A

GENERAL SYSTEM

OF

CHEMICAL KNOWLEDGE;

AND ITS

APPLICATION

TO THE

PHENOMENA OF NATURE AND ART.

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IN ELEVEN VOLUMES.

TOGETHER WITH A SET OF SYNOPTIC TABLES IN LARGE FOLIO.

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BY WILLIAM NICHOLSON.

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A

SYSTEM

OF

CHEMICAL KNOWLEDGE.

EIGHTH SECTION.

Of the Animal Subſtances.

FIRST ORDER OF FACTS.

Generalities reſpecting the Structure and the Compoſition of the Animal Subſtances.

ARTICLE I.

Of the Structure of Animals.

1. AS I have conſtantly proceeded in the examination of the chemical properties of natural bodies from the moſt ſimple to the more compounded, it is neceſſary that I ſhould place the animal matters after the vegetable, becauſe they are of a more complicated order of compoſition. Accordingly their analyſis being more difficult, is leſs advanced, and the reſults that are drawn from them are leſs numerous and leſs certain.

Whatever differences are obferved between thefe two claffes of objects, there exifts, however, infinitely more relations between the animal and the vegetable fubftances than between the latter and the foffil matters that have been treated of before them; on account of thefe analogies the animal matters fhall here be confidered in the fame manner as the vegetable, though with fewer details, as their hiftory is lefs complete. I fhall comprehend all that appertains to their chemical properties under four orders of facts.

The firft fhall prefent what is requifite to be known concerning their ftructure and their general properties both as living bodies and as particular compounds, in order to render the expofition of their chemical properties fufficiently intelligible.

In the fecond order of facts I fhall exhibit the whole of their general chemical characters or the feries of their diftinctive properties difcovered by chemical inftruments.

The third order of facts fhall be devoted to the hiftory of the chemical properties of each particular animal matter.

Laftly, I fhall refer to the fourth order of facts which will terminate this fection, the applications of the chemical properties, both general and particular to the exercife of their functions, and to the bafes of phyfiology or animal phyfics.

2. The

2. The firſt fact, which, as one of the moſt remarkable, ſtrikes in the moſt forcible manner the mind of every obſerver who compares the animals with the other natural bodies, is their exiſtence as ſubordinate to that of the vegetables. There is no one who does not conceive that without the plants no animals could exiſt, and that it is from them that they derive the nouriſhment which the mineral ſubſtances cannot afford them. Thus the vegetables, conſidered with reſpect to the rank which they occupy in the ſcale of beings, and to the relations which exiſt between them and the other productions of Nature, are placed in the middle between the foſſils and the animals. They borrow elements from the firſt, they combine them three and three by the power of vegetation; they prepare by the aid of this combination the alimentary matter for animals, they draw from the boſom of the earth ſubſtances which they bring to its ſurface, and which they aſſimilate in ſuch a manner as to render them proper for the ſupport of animal life: they can exiſt without the animals, but theſe cannot exiſt without them, and if they are not poſterior to them in their formation, they can only be their contemporaries.

3. It follows from this conſideration, that as the true problem of the nature of the vegetable ſubſtances compared with the mineral matters conſiſts in the formation of the former at the expenſe of the latter by the vegetative

power, that of the knowledge of animal fubftances compared with the vegetable muft be comprehended in the inveftigation of the converfion of the latter into the former. An animal of a given weight grows in a proportion alfo given, and in all its organs at the fame time. The augmentation of bulk which it experiences can proceed only from the vegetable matter which it adds to its original weight. This fingle fact well afcertained proves inconteftibly that the vegetable fubftances is converted into its own body, and becomes animal fubftance by a power innate in the body of this animal, a power which is termed *animalization*; and it fhows at the fame time that it is by difcovering the laws, the phenomena, and the caufes of this converfion, that we fhall be able to acquire a knowledge of the nature of the materials which compofe its body.

4. In order to acquire this knowledge, fo very difficult to be obtained, and with refpect to which we have hitherto only a few data, it is fufficiently evident that it is indifpenfably neceffary we fhould firft know how the animals are conftituted, or organized, efpecially in comparifon with the vegetables, and this is what I here term their ftructure. Rapid and general notions upon this fubject will be fufficient for our inquiries. Naturalifts define animals as living organized beings, which change their fituation, move themfelves, tranfport themfeves through fpace, and are endowed with fenfibility:

bility: they diſtinguiſh them ſufficiently from vegetables by the two latter properties; but this very looſe diſtinction does not fulfil the purpoſe that is to be attained. A number of other ſtill more ſtriking characters alſo diſtinguiſh animals from the vegetables; the external and internal forms differ much in theſe two claſſes of organized bodies. A ſlight ſketch of theſe characters muſt precede and illuſtrate the ſtudy of their chemical properties, as has been done with reſpect to the vegetables.

5. The body of animals reſembles that of vegetables only in a very few ſpecies. We find it divided into different regions or parts of a very different ſtructure, eſpecially in the beſt organized and moſt perfect animals. Of theſe, are particularly diſtinguiſhed the head, the trunk, and the extremities.

The firſt, including in the cranium the important organ of the brain, and the origin of the nerves, bearing outwardly the principal organs of the ſenſes, eſtabliſhes a direct communication and re-action with all the external objects by the eyes, the ears, and the noſtrils. The cavity of the mouth, which is placed in it, conducts to the organs of digeſtion and of reſpiration, and begins each of theſe functions.

The trunk compoſed of vertebræ ſupports a firſt oſſeous muſcular and membranous cavity, in which are lodged the heart and the large veſſels, the lungs, and the trachea; another

cavity

cavity provided only with mufcles and membranes in front, in which are difpofed under the diaphragm, which feparates it from the thorax, the vifcera of digeftion, the ftomach, the inteftines, the pancreas, the fpleen, and the liver, the internal organs of generation diftributed differently in two individuals which form the fexes in the greater number of animals, and alfo thofe which fecrete the urine.

The limbs or extremities, the one fuperior or anterior, the other inferior or pofterior, formed of bones in their centre, of mufcles which cover and move them one upon the other like levers, terminated at their extremity the moft remote from the trunk by divifions more or lefs regular, ferve the animals for feizing or repelling bodies, for removing them from, or bringing them nearer to them, and for bringing them into the medium which they inhabit.

6. Thefe three grand parts of the body of animals, the head, the trunk, and the extremities though very different in their ufes and apparent ftructure, are, however, formed of fibres and laminæ which conftitute textures or kinds of organs which are found throughout. Thefe organs, the firft foundations of the animal body are the bones, the blood, and lymphatic veffels, the glands and the nerves.

The bones are the folid parts which determine the form of the body to which they give extent and folidity. They are connected with each other by folid membranes which are termed *ligaments*; their articular furfaces are covered with

with a white layer, lefs hard than themfelves, compreffible and polifhed, called *cartilage*, and moiftened in their articulations with an unctuous liquid called *fyncvia.*

Over the bones are applied bundles of fibres, united into larger bundles, deftined to caufe the bones to roll one upon the other, and which are called *mufcles;* they have at their extremities white cords, which effect their attachment or infertion into the bones, and are termed *tendons;* they are outwardly furrounded, and held together by hard elaftic membranes, with brilliant fibres, which are called *aponeurofes.* The mufcles are the organs of motion, and give the external form, the torofity, the roundnefs, the projections, and the depreffions of the furface.

Tubes or ftrong membranous veffels, proceeding from the cavities of the upper part of the heart, ramified and extended from thence throughout the whole body, conveying the blood which dilates them, and caufes them to beat, and thefe are known by the name of *arteries.* At their extreme terminations they open into other tubes or veffels, which are lefs dilated, lefs elaftic, and lefs refifting, which take up the blood, and carry it from the ramifications to the branches, and to the trunks in the cavities of the bafe in the heart; thefe are the *veins.* Thefe two orders of canals form together the whole of the blood veffels.

Under

Under the ſkin and between the muſcles, another order of veſſels, thin, tranſparent, tortuous, contracted in different places by interior folds, filled with a white and tranſparent liquid, abſorb and ſuck in this liquid from every part, unite and ſeparate innumerable times, and all paſs into the abdomen, behind the inteſtines and the ſtomach, whither they carry the liquid, which there flows into one, two, or three trunks, which aſcend into the thorax, and open into a vein ſituated near to the heart, where the liquid called *lymph* is mixed with the venous blood; theſe veſſels are called abſorbents, or lymphatics; they are diſtinguiſhed into the ſuperficial and the deep; they are very much varied in their ſtructure, and innumerable in their maſs. The chyle, the product of digeſtion, is mixed with the lymph which they contain in the abdomen, and is poured with it into the venous blood near the heart. The order of abſorbent veſſels, which immediately draw in the chyle in the inteſtines, are particularly diſtinguiſhed by the name of *lacteal veſſels.*

In many regions of the body of animals we find bundles of blood veſſels, contorted in all directions, and having different forms, connected and preſſed together by very fine membranes, which are termed *cellular texture.* Theſe veſſels thus balled together, interlaced very cloſe to each other, and forming a kind of grains cloſely united with one another, very

various

various in their volume, are terminated, befides the veins which receive the blood again from them, by canals more or lefs wide, by refervoirs more or lefs ample, which pour into different regions, particular fluids. Thefe circumfcribed collections of veffels are called *conglomerate* glands. In this clafs or rank, the brain, the lachrymal glands, which prepare the tears, the parotids, the maxillary, and the fublingual glands which fecrete the faliva, the thyroid, placed under the larynx, the ufe of which is not known, the glands of the mammæ, which prepare the milk, the pancreas, forming the pancreatic juice poured into the firft of the inteftines, the liver, in which the bile is prepared, which flows together with the preceding fluid, the kidneys in which the urine is fecreted, and the tefticles, the fource of the femen. The abforbent veffels united into fmaller intertextures, conftitute almoft every where, but efpecially along the large blood-veffels of the neck, of the thorax, and of the extremities, at the axillæ, &c. *conglobate* glans, fo called, becaufe they are frequently rounded into a kind of globules.

From the bafe of the cerebrum, the cerebellum, the medulla oblongata, and the fpinal marrow, organs placed in the cranium and the vertebral canal, proceed white cords, which pafs out through holes, or fiffures, and fpread themfelves, dividing into branches, into ramifications, and into filaments, more and more minute, into all the other parts with the arteries, the

the veins, and the abſorbent veſſels. They eſtabliſh a communication with the ſeat of the ſenſations and ideas, and ſerve to form or modify both, as well as to convey the cauſe of motion according to the impreſſions made upon the organs of the ſenſes.

All theſe textures are glued together, though diſtinct and eaſily ſeparable, by a ſeries of very fine, and very tranſparent, flat lamellæ, forming between themſelves a multitude of continuous and communicating cells, on which account the whole has been called the *cellular texture.* This texture retains all the parts in their reſpective places; it is looſe and ſuſceptible of diſtention: it is this which unites the muſcular fibres into faſciæ, the different veſſels into bundles. It ſupports ſuch a great quantity of abſorbent veſſels upon its lamellæ, that modern anatomiſts believe it to be intirely formed of them. As it is always lucidated with a gluey and mucilaginous liquor, it has alſo been called mucous texture. We may repreſent it as a ſponge of the ſame form as the animal body, and into the cavities of which all the organs are as it were ſtuffed. The fat is depoſited in its cells.

7. Beſides theſe firſt organic elements, or general textures, which extend throughout the whole body of animals, which enter into the formation of the different regions of this body, we muſt alſo diſtinguiſh; 1. An organ, named ſometimes *lungs*, ſometimes *bronchiæ*, ſometimes

times *trachea*, and which is deftined to eftablifh a communication, an uninterrupted contact between the blood, or other different humours of animals and the air, or the aërated water which they inhale; 2. A fyftem of organs continued between two orifices, frequently placed at the two oppofite extremities of the body, which receives, divides, diffolves, digefts the aliments, and which reprefents in general a canal alternately dilated and contracted, provided with inftruments and liquids, deftined for bruifing or diffolving the alimentary fubftances, to which canal are attached conglomerate glands, which pour into it diffolvent juices, efpecially the liver and the pancreas; 3. A third fyftem of organs deftined to perpetuate the fpecies by generation, partly concealed in the interior of the body, partly fituated or projecting outwardly, divided frequently into two fexes, the union of which, urged by inftinct, is neceffary for the re-production of the individuals. The one of thefe fyftems appears to contain the individual ready formed, but void of life; this is the female organ, or the agent of the feminine fex; the other, or the male organ, furnifhes an exciting vivifying liquid, which communicates motion and life to the germ; 4. A fourth fyftem which terminates, envelops, and contains all the others under the form of *teguments*, which cover the body, and which is in immediate contact with the water, or the air in which the animals live.

8. Each

8. Each of the claſſes of organs, of which I have ſpoken, conſtitutes a particular ſyſtem, having a ſtructure, characters, uſes, and nature, different from thoſe of the other ſyſtems, actuated by a motion, an appetite, a manner, a ſenſibility, an activity, an aſpect, we might even ſay a life, which is peculiar to it. Thus we have to diſtinguiſh in the anatomical contexture of animals, the oſſeous, or ſolid *ſupporting* ſyſtem, the muſcular *irritable* ſyſtem, the ſanguiferous *circulating* ſyſtem, the lymphatic *abſorbent* ſyſtem, the glandular *ſecreting* ſyſtem, the nervous *ſentient* ſyſtem, the cellular *communicating* and *connecting* ſyſtem, the pulmonary *heating*, *ſanguifying* ſyſtem, the alimentary, or digeſtive *aſſimilating* ſyſtem, the genital *perpetuating* ſyſtem, and the cutaneous *perſpiring* ſyſtem. Each of theſe ſyſtems is connected with the others, and it is from their agreement, their aſſociation, their concord, their ſimultaneous and proportional action, that the affection of the animal economy reſults. The more of theſe ſyſtems are united in animals the more perfect they are. Man, who has them all, and in a regular and juſt proportion, is greatly ſuperior to all the other animals. The diverſities of force and energy, varied in the different ſyſtems, and their action, conſtitute the different temperatures in the ſame ſpecies.

9. On the variation of relations of ſymmetry, of number, of proportion between theſe ſyſtems, are founded the differences which exiſt between the animals and the claſſifications which

which have been made amongſt them; beginning with man, and deſcending through degrees of organic degradation, more or leſs perceptible, down to the inſects, the worms, and the zoophytes, in which many of theſe ſyſtems are either wanting or defective, for the more the anatomy of the animals advances, the more we find that the differences between them conſiſt rather in the little harmony between the ſyſtems of the organs which conſtitute them, than in the want or total abſence of theſe ſyſtems, as was at firſt believed. Ariſtotle firſt perceived, and this beautiful reſult has ſince been confirmed by innumerable anatomical obſervations, that the differences of theſe internal ſyſtems in the body of animals, were in ſome degree indicated by great differences in their apparent organs, or in the external parts; that this ſtriking diſparity followed and announced, eſpecially in the extremes, the difference of the moſt important ſyſtems, thoſe of the ſtomach, of the organs of reſpiration, of the brain, and of the nerves. The ſkin, naked, or covered with hair, with wool, provided with feathers, covered with ſcales, with a ſhell, the extremities more or leſs diſſimilar, long, ſhort, defective, or more or leſs divided; the fingers, more or leſs numerous or divided; the ſpinal column terminated below by the anus, formed of a greater or leſs number of pieces or vertebræ, prolonged into a tail more or leſs long, the face vertical or oblique, more or leſs oblong; the jaws more or leſs prominent, and

and confequently the noftrils, the mouth, and the tongue, more or lefs elongated; the cranium more or lefs fmall, the forehead more or lefs projecting, with or without offeous appendages or horns; the occipital foramen, placed more or lefs behind, and in a line more or lefs approaching to the horizontal or vertical; the jaws, deprived of teeth, or having only few, or only certain claffes, or only one of their parts;—thefe are the moft remarkable differences, and moft important characters which have been employed for diftinguifhing and defcribing the animals from their divifion into claffes, to the feparation of genera.

10. According to this varied ftructure, beginning with the moft ftriking differences, taken from the heart, with two, or with one interior cavity, with red or with white blood, circulating either entirely or only in part through the pulmonary organ, from the ftomach fingle or multiplied, from the brain and the nerves more or lefs abundant, from the mode of generation, viviparous, or oviparous, and defcending fucceffively to the confiderations of the body, provided with extremities, four, or only two in number, or deftitute of thefe extremities, of the varied form of thefe parts, and of their divifion, of the number, of the fituation, of the relation, of the teeth, of the organs of maftication in general, of the fkin, naked, covered with hairs, with prickles, with fcales, &c. &c.—All the animals, after man, the chief and primitive

primitive type of organized beings, have been diftinguifhed into eight claffes, namely the mammalia, the birds, the reptiles, the fifhes, the teftacea, the infects, the worms, and the zoophytes. The latter, the moft degraded in their ftructure and their functions, fixed to the foil upon which they have been produced, reduced almoft to the condition of the vegetables, to which they approach, and with which they have long been confounded, form the laft degree in the fcale of animals. Without entering upon this divifion and this claffification, into details foreign to my object, I fhall content myfelf with obferving, that all the beings comprehended in thefe ten claffes, at the head of which man ought to be placed in a particular and diftinct rank; though he has the moft ftriking analogies of ftructure and of orginization with the mammalia, refemble each other in the characters of animality, locomobility, the communications inceffantly kept up with the medium which they inhabit, the prompt and fudden re-action of the external objects upon their functions, and efpecially the union of the digefting, circulating, refpiring, moving, fentient, and generating organs. It has been thought, not without fome foundation, that the immenfe tribes of which thefe fix claffes of animals confift, form amongft themfelves a continued feries, an uninterrupted chain of beings, connected by relations more or lefs clofe, and defcending, by almoft infenfible gradations,

 from

from man, the model of animals, down to the polypus, the microfcopic animalcules, and the fponge. The conftruction of this chain has much occupied the naturalifts, efpecially Bonnet; and if their inveftigations have not intirely anfwered their wifhes, they have at leaft had the advantage of enabling them to compare thefe beings with more accuracy, and to find between them relations which would not otherwife have been fufpected.

ARTICLE II.

Of the Functions exercifed by the Organs of Animals.

1. IN the preceding article I have only fpoken of the general ftructure of animals, of their parts, and of their organs, in order to point out their differences from the vegetables which they otherwife refemble in fome general properties. It was a general notion of their anatomy which I wifhed to give; but this fuccinct account of their organization, reprefents as yet only the inanimate machine, and as it prefents itfelf to the fcalpel of the anatomift. We fhould have only a very imperfect idea of thefe beings, if we did not confider their animated machine, if we did not fee their parts re-acting

re-acting the one upon the other, and actuated by the motion which the living force communicates to them. In prefenting a fketch of the exercife of this force, in a narrow compafs, I have no other intention than to afcertain the real characters with which animals are endowed, inftead of proceeding blindfold in the examination of their chemical properties, which are to occupy this fection.

2. The animal coming out of an egg, or the womb of its mother, after having received, by the fecundation of its germ, the motion which animates it, and after having experienced in its membranes, either during incubation or in the uterus, the firft developments which mark out its traits, and determine its fpecies, and even variety, fulfils a deftiny which all mankind obferve in the living beings. To be born, to increafe in bulk, to acquire its full growth, to remain for fome time in this perfect ftate, to re-produce beings refembling itfelf, afterwards to decline, and gradually to lofe a part of its forms, its powers and its ftrength, laftly to perifh in confequence even of the efforts which have fupported its exiftence:—this is the circle which Nature has marked out for it, and which comprehends the duration as well as the principal events of its life. She has placed in it a power, which caufes it to defire, to take and digeft its nourifhment, foon to affimilate it with its own fubftance, to augment the mafs of its body, to repair its wafte, to carry the fuper-

fluous parts into certain reſervoirs, and eſpecially into thoſe which ſerve for the purpoſes of generation, and to reject a ſuperabundant or unaſſimilable portion by canals deſtined for this uſe.

3. This principal effect of life ſuppoſes a diſcernment, an appetite, a judgment, which require an immediate communication between the body of the animal and all the beings which ſurround it; ſo that it can reject, remove from itſelf, take, or approach to itſelf thoſe beings, accordingly as they are beneficial or hurtful to it. In this exerciſe of its life, all the organs which conſtitute the animal, all the ſyſtems which form the totality of its texture, act ſimultaneouſly, with order, with conſiſtency, with regularity, and each fulfils a particular function. The aſſemblage and deſcription of theſe functions compoſe what is named animal phyſics, or phyſiology. Ten functions are reckoned to preſide over life, which may be diſtinguiſhed, eſpecially when it is propoſed to exhibit their ſimple reſult, into four claſſes.

The firſt claſs comprehends the functions which immediately ſupport life, and which were formerly called *vital* functions, becauſe the ceſſation of any of them produces the inſtantaneous death of the individual; theſe are the *central ſenſibility*, *reſpiration* and *circulation*.

The ſecond claſs comprehends the functions, which immediately ſupport life, or which prolong

long its exiftence and duration; they have been called *natural* functions; they may be ftopped for fome time without life being deftroyed. Such are *digeftion, fecretion, nutrition, offification.*

To the third clafs belong the functions which render life animated, re-acting in fome meafure upon the furrounding bodies, which eftablifh direct communications between the living animals and the beings which furround them; thefe diftinguifh the animal the moft from the vegetable; they conftitute its fuperiority; they are *irritability* and *exterior fenfibility.*

Finally, I rank in the fixth clafs the function which communicates life, which perpetuates the fpecies; this is *generation.* I fhall prefent a fketch of the phenomena of each.

4. By *Central fenfibility* I diftinguifh the function of the cerebrum, of the cerebellum, and efpecially of the medulla oblongata, which feems to be the primum mobile of all the others, the perfect integrity of which is indifpenfable to life, at leaft in the animals in which thefe important organs are well conftituted. It has fuch an influence upon all the functions, that none of them can exift unlefs it be in its complete plenitude. Thus in man, in the mammalia and in the birds, a very flight preffure upon thefe organs renders the individual foporofe, paralytic, weakens, alters, or annihilates his external fenfes; a too ftrong preffure, a puncture a little deep, an incifion, or a wound which penetrates to

the centre of the medulla oblongata, deſtroys life as ſuddenly as lightning. Thus an animal is inſtantaneouſly killed by thruſting a ſmall knife between the firſt vertebræ and the occipital. The cauſe and the mechaniſm of this eminently vital function are entirely unknown, as is almoſt every thing that appertains to the living properties of the medullary pulp of the cerebrum, of the cerebellum, of the medulla oblongata.

5. *Reſpiration* is not a function immediately vital in all claſſes of animals; it has this character only with thoſe in which the blood is obliged to paſs through the reſpiratory organ previous to its being ſent into all the regions of the body, as in man, in the mammalia, and in the birds. With the others in which the blood is not obliged to follow the courſe that has been indicated, at every moment of life, reſpiration may be retarded, interrupted, partial, momentaneous, periodical, or in general irregular. Its purpoſe is to bring the blood, either wholly or in part, at every inſtant, or at certain intervals into contact with the air and aërated water. The lungs in man, in the mammalia, and in the birds, the gills in fiſhes, the tracheæ in the inſects and worms, are the organs of this function. It conſiſts in two alternate motions, the one by which the air is received, or *inſpiration*, the other by which the air is evacuated, or *expiration*; an effect takes place between the air and the blood, which modifies the

the latter and renders it adapted for life, and the nature of which chemiftry, as fhall be feen, teaches us to determine. It contributes to fupport the circulation, which, in a great number of animals would not take place without it. The diaphragm, the ribs, the mufcles attached to them, exercife its motions in the moft perfect animals, in the birds it is ftill more energetic on account of the organs acceffary to the lungs, which, with them, extend into their bones and their feathers. It extracts the air from the water in fifhes, which cannot live in water that has been boiled.

6. *Circulation* is the motion of the blood from the heart into the arteries, and from thefe into the veins, which carry it back again into the heart. It takes place in animals without interruption. The heart is endowed with a great force for expelling this liquid, which, as it dilates the arteries, caufes them to pulfate: this firft order of veffels poffeffes a power of contraction which propels the blood into the laft ramifications; the veins do not poffefs the fame power; the blood is propelled in them by the fide which preffes it, by the valves which prevent its retrograde motion, by the vacuum which its progrefs produces, by the preffure of the adjacent parts and efpecially of the mufcles. This function is two-fold in man, in the mammalia and in the birds; the one is pulmonary, and carries the blood by a fhort paffage from the right to the left cavities of the heart; the other, which

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is general, carries it from the latter cavities into the whole body; and brings it back to the right ſide: theſe two circulations form together a route, which is pretty well repreſented by the type or figure 8. In the animals placed below the birds, the heart has not the ſame number of cavities, and the blood does not take exactly the ſame courſe; reſpiration is not neceſſary to the integrity and the continuity of its circular motion; the cavities, the canals through which it paſſes, the courſe which it takes, vary, and deſcend, in ſome meaſure through a ſcale of degradation down to the loweſt claſſes of animals. The three inferior claſſes, the teſtacea, the inſects, and the worms, have white cold blood, a heart imperfectly organized, or a dorſal veſſel which ſupplies its place, an irregular and very feeble circulation. The zoophytes, the laſt claſs, have neither heart nor circulation.

7. Digeſtion conſiſts in the introduction of aliments into a canal or ſac in which their nature is changed, they become ſoftened, diſſolve and ſeparate into two ſubſtances: the one, the chyle, which paſſes into the veſſels in order to renovate the blood, and ſerve for nutrition; the other which paſſes out of the body in the form of excrement. This function is very much varied, both with reſpect to its organs and to its reſults, in the different claſſes of animals, and frequently even in different genera of the ſame claſs. We may, however, diſtin-

diftinguifh in it four periods: the firft, the preparatory, comprehends the bruifing, maftication and deglutition; the alimentary bolus is formed and conducted into the ftomach in this firft period; the fecond, which comprehends the digeftion in the ftomach, or the change of the alimentary matter into chyle, or homogeneous pulp; the third, which belongs to a fecond change produced in the inteftine, and which feparates the chylous matter from the excremental; finally, the fourth, which comprehends the abforption of the chyle that has been formed, by the lacteal veffels, and the expulfion of the excrement.

Thefe four periods are very diftinct in man, in the mammalia, the birds, the reptiles, the fifhes, and the infects. They prefent in them a multitude of modifications, determined by the form of the organs of manducation, deprived of teeth or provided with teeth of very different kinds, deftined for bruifing, tearing, cutting; by that of the ftomach, fimple or quadruple, or divided into craws, of the gaftric juice more or lefs diffolvent or weak; by the nature and the quantity of the bile and of the pancreatic juice, which form the fecond digeftion, and effect the feparation of the digefted aliments into a chylous part and an excrementitious portion; by the very various length of the inteftinal tube, which in general is fhort in the carnivorous, and very long and contorted in the frugivorous and granivorous animals;

by

by the form, the ſize, the texture, the ſecretory force of the pancreas, of the liver, &c.

This function has not the ſame diſtinct periods in ſome inſects, the teſtacea, the worms, and eſpecially the zoophytes. With the latter, it is merely a ſimple paſſage of the aliment into a ſac or a tube, in which a ſuction, equal in all points, is performed.

8. *Secretion* is ſo termed becauſe it is ſuppoſed to ſeparate different humours from the blood. It is performed by the glands; it is in this manner that the ſaliva is ſeparated in the ſalivary glands, the bile in the liver, the urine in the kidneys, the pancreatic juice in the pancreas, the ſynovia in the articular glands, the ſperm in the teſticles, &c. &c. It is, however, not a mere ſeparation, which would preſuppoſe that each of theſe liquids was contained ready formed in the blood; but a real particular change of the latter in each gland, as I ſhall ſhow at the cloſe of this ſection. There is no function in animals which is more general, more extended and more varied than this. It preſents a multitude of particularities in the claſſes, the genera, and even the ſpecies of theſe organized beings, according to the particular wants of the ſpecies. It conſtantly conſiſts in a preparation of the blood before it arrives at the ſecreting organ, in its change and in the ſeparation of the matter ſecreted in the interior of this organ itſelf, and in the exit or ejection of this humour, frequently effected by an excre-

tory duct. This latter circumftance is owing to the vital action, a kind of irritable motion of the excretory duct, which experiences an orgafm, a very well marked erection, at the contact or at the mere fight of the ftimulant appropriate to it, as the faliva which runs and gufhes out of the falivary ducts, at the fight or even at the mere idea of the aliment that excites the appetite, &c.

9. *Nutrition* is the end of digeftion and affimilation. The alimentary matter converted into chyle, poured in this form into the blood, affimilated by its mixture with this liquid, vivified by refpiration and circulation, is carried by the latter into the different organs; it depofits in each the fubftance proper for exactly fupplying the lofs which it has fuftained. It is changed efpecially into lymph, which being tranfported into every part and into all the cavities, all the cells of the cellular texture, furnifhes there that mucous, plaftic jelly, difpofed for forming the tranfparent and gelatinous laminæ of which moft of the animal fubftances are formed. On this account the lymph has been appointed as its nutritious bafe, and the mucous texture as its feat or organ. However, the idea of nutrition muft be ftill more generalized, and each mufcular, pulpy, membranous, parenchymatous, offeous organ, confidered as poffeffing the property of appropriating to itfelf, in the blood and the lymph which paffes through and penetrates it, the matter deftined for

for its own repair. In fact, the excess of this nutriment is taken up again, with the part of the organ in some measure worn and melted, by the absorbent vessels, which pouring it into the tide of the circulation, renew or transport it outwards by transpiration. The nutrition is much more active in the first periods of the life of the animal, when its organs, which are dilatable and extensible to a determined degree, grow till they have attained this term. On this account the digestive powers are at that period of life more energetic, the appetite keener, and the quantity of aliment required more considerable. It is modified in the different classes of animals according to their nature, and very simple in the last.

10. *Ossification* deserves to be considered as a particular function, on account of the important part which it acts in the phenomena of life; the formation of the bones in the first periods of the life of animals has a great influence upon their existence and their strength. Though this is really nothing more than a secretion of osseous and solidifiable matter, in the gelatinous organ, which forms the base of the bones, this secretion is so general, it holds such an important place in the animal economy, that it ought to be considered and studied in particular. The bones, after having been membranous in the first formation of animals, becomes solidified at their centre and in divergent rays in the flat bones; in three points, at their middle

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and their two extremities, in the long bones; in the latter the bones remain for ſome time ſeparated from the body of the bone under the name of epiphyſes; they do not glue themſelves together till about a ſixth of the period of life has elapſed. Towards the period of old age, the bones become more brittle, becauſe the proportion of the ſolid ſalt increaſes in them. Theſe organs, the totality of which conſtitutes the ſkeleton, do more than give form, extent, and ſupport to the different parts of the body of animals. They are alſo levers movable upon each other, which cauſe theſe parts to aſſume various ſituations with reſpect to one another, which favour locomotion, which ſerve for the execution of all the motions and the action depending thereon. We might therefore refer oſſification in this point of view to the claſs of functions, which eſtabliſh a communication between the animals, and the bodies which ſurround them.

11. *Irritability* is one of the animal functions which preſent the moſt wonderful circumſtances and phenomena difficult to be comprehended. This name is given to the living power by which the muſcles or the organs, which form the fleſh of animals, contract themſelves, change their dimenſions, approach and move the bones one upon the other. Their contraction or the diminution of their length, and their dilatation in breadth and depth, their change of dimenſion in general, are effected by the aid of a ſtimulus, which is directed by the will,

will, and which ſeems to proceed from the focus of the central ſenſibility; they are executed by a motion, the cauſe of which is not known. We know that the concurrence of the veſſels and nerves is neceſſary, in order that it may take place in the animals in which the laſt-mentioned organs are found. It is alſo known that by eſtabliſhing between the nerves and the muſcles a communication with the aid of two different metals in contact with each other, we cauſe this motion to be produced at will, and this important phenomenon bears the name of Galvaniſm, becauſe it was diſcovered by Galvani, an Italian phyſician. Finally, all the experiments have ſhown that this function, which exiſts in all animals, is very energetic even in thoſe whoſe fleſh is white, and down to the Zoophytes, in which neither brain nor nerves have been diſcovered. A puncture, a bright light, or a cauſtic, excite contraction when they are placed in contact with the muſcles. It is to this grand property of the fleſhy fibres that all the motions of animals are to be attributed, from that of the heart which acts inceſſantly and without their participation, to that of the ſmalleſt of their muſcles, which they cauſe to act at will.

12. The exterior ſenſibility comprehends all the ſenſes placed in different regions of the bodies of animals, but more particularly in that of the face, where they are almoſt all united in a line very near to the brain. The ſtudy of this function, which preſents the organs and the ſenſa-

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tions of the ſight, the ſmell, the taſte, hearing, and touch, is of all the parts of phyſiology, that which preſents to the obſerver the greateſt number of remarkable facts, and the moſt varieties in the ſtructure and relative extent of each of the ſenſations in the different claſſes of animals. Theſe ſenſations are in general perceived by the nervous extremities ſpread out in a tranſparent jelly at the bottom of the eye, into ſhort and pulpy filaments in the internal ear, into flat and long filaments in the noſtrils, into projecting papillæ upon the tongue, and into ſoft and extremely numerous tubercles under the ſkin. The impreſſion made by light, by ſounds, by ſmells, taſtes, ſurfaces, is tranſmitted to the focus of central ſenſibility by the nerves which propagate it to this focus, which is called the *ſenſorium commune*. The ſentiment of pleaſure or pain, which follows this tranſmiſſion, and the compariſon of theſe different, ſucceſſive, multiplied, modified ſenſations, gives riſe to the ideas and produces all the voluntary motions deſtined for the ſupport of the life of the animal, by furniſhing it with the means of removing or avoiding that which is pernicious, and approaching or ſeizing that which is beneficial to it. None of the animals have, in the number and the relations of their ſenſes, and conſequently in that of their ſenſations, the ſame harmony and proportion which conſtitute the perfectionable character of the human ſpecies.

13. Generation,

13. Generation, the moſt incomprehenſible and the moſt hidden of the functions of the body of animals, by perpetuating theſe beings, carries into theſe individuals which all proceed from the ſame ſtock, a reſemblance of form, of ſtructure, and of properties which rigorouſly determine the ſpecies. In this function we ſcarcely know the organs by which it is accompliſhed, and the reſult of their mutual action; even the mode of their exerciſe, the cauſe of their effects, the mechaniſm of fecundation, are covered with a veil the moſt obſcure and impenetrable to man. Anatomy and phyſiology have nevertheleſs made numerous and important diſcoveries, and eſtabliſhed ſome general truths concerning this myſtery. They have ſhown that all the animals which exiſt have formed an integrant part of animals ſimilar to thoſe from which they have been ſeparated; that this ſeparation, this detachment of animals from their parents is effected in ſeveral different ways, that in the animals the moſt ſimple and the leaſt complicated in their ſtructure, there are formed, as in the vegetables, buds filled with ſmall animals ſimilar to thoſe from which they proceed, and which detach themſelves at a certain period of growth, or that a fragment of their ſubſtance ſeparated from a firſt adult individual, forms an animal intirely ſimilar to this, like the ſlips in plants; that in others, and thoſe are the moſt numerous, the concurrence of two organs, the one under the name of ovarium,

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containing the animal ready formed, but not animated and living, which is the feminine organ; the other containing a liquid capable of exciting by the flighteft contact the motion of life in this embryo, which is the male organ; that thofe two organs neceffary for the fecundation and re-production, are fometimes united in one and the fame individual in fuch a manner as to render it either fufficient for itfelf, or to admit of a double production in each individual, which then is androgynous; that moft commonly the two organs are feparated in two individuals of the fame fpecies, which is termed *fex*, and that they require, for the purpofe of fecundation, their union or copulation; that this union of the two fexes is folicited by an imperious want, by an appetite more or lefs violent, which has its period in every year; that this appetite does not fhow itfelf thus except with the power of fatisfying it, and of engendering when the growth of the animal is completed, or when the animal is perfect; that it appears to arife from an excefs of nourifhment, of which the organs, which no longer grow, are no longer in want; that on this account it becomes more powerful, much more frequent, and has no longer any regular period when the animals are furnifhed with a very abundant and very fucculent nutriment; that when the act of fecundation has been performed, the embryo animated by the fpermatic liquor grows, either in the womb of the female, or

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out of it; that after a certain determined time it comes out of it, inclofed in a fhell or membrane in the form of an egg, and that it now requires only a certain temperature in order to be hatched, as in the oviparous animals; that in the fame manner, in the viviparous animals, the embryo, having become a fetus by fecundation, is developed in a given time, lives in the womb of its mother immerfed in a liquid, and inclofed in different coverings, and that it leaves the womb when it has acquired a certain growth; that when it has once left the egg or the womb, the young animal, in the firft claffes of animals, ftill retains for fome time a particular ftructure in the organs of refpiration and circulation, but gradually lofes this difference, in proportion as it refpires and nourifhes itfelf after the manner of its parents; and that finally at the end of its growth, its being is completed and perfected to the period when the neceffity of producing its like, of communicating the excefs of life which it enjoys in all its plenitude, is felt with the laft development of its organs.

ARTICLE III.

Of the Succeſſion and of the Hiſtory of the Diſcoveries in Animal Chemiſtry.

1. HOWEVER rapid the ſketch of the ſtructure, and of the functions of animals, comprehended in the preceding articles, may be, yet it is ſufficient to ſhow the difference which exiſts between them and the vegetables; and though intended only to ſerve as an introduction to the examination of their chemical properties, it is alſo ſufficient to ſhow, that, notwithſtanding the difference which ſubſiſts between theſe two claſſes of beings, there nevertheleſs exiſt between them a greater number of relations and analogies than are remarked between the plants and the minerals. In the inveſtigation of the real differences which ſeparate theſe two orders of organized beings, the labours of chemiſts have not been fewer than thoſe of the anatomiſts, and if the ſucceſs of their experiments has been inferior to that of the deſcription and knowledge of their organs, modern chemiſtry has ſupplied this deficiency, which depended only upon the imperfection and the inaccuracy of the means and inſtruments which ſhe has poſſeſſed only for ſome years paſt. It will

be an inquiry, no leſs curious than uſeful, how this ſcience has arrived at the point of perfection which it has now attained in this kind of analyſis, through what ſtages it has paſſed, and what may ſtill be expected from it, from the light which it has already thrown upon animal phyſics.

2. The ancient chemiſts, occupied in the ſearch of imaginary properties, in moſt of the natural productions, either for the chimera of the opus magnum, or for the treatment of diſeaſes, have given nothing but erroneous notions concerning the animal matter. Their decompoſition by fire was the only method which they followed, and the ſource of theſe errors. Nothing uſeful is to be found before the middle of the ſeventeenth century. Few chemiſts even occupied themſelves with them, either on account of the diſagreeableneſs and fetidity of this analyſis, or on account of its difficulty, or laſtly on account of the ſum of collective knowledge which it required, and the few chemiſts whom it intereſted, in times when all were zealouſly engaged in the examination of the minerals. I divide the hiſtory of animal chemiſtry into eight epochas, each marked by ſome great diſcovery which characterizes it, more than by the time in which each of them can be fixed.

3. The firſt epocha, which dates from the middle of the ſeventeenth to the beginning of the eighteenth century, is remarkable by a kind

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of invafion which chemiftry made into medicine, by introducing into it its ridiculous theory of the acids and alkalis. It fucceeded the chimeras of the panaceas, the elixirs of life, and potable gold, which the alchemy of the adepts had before introduced into the practice of the art, which at leaft was corrected by the beneficial acquifition of the mercurial and antimonial remedies, of opium, &c. Tachenius, Willis, Vieuffens, Sylvius, were the moft celebrated propagators of chemical medicine, founded upon the acids and alkalis. The functions of animals, according to them, were performed by effervefcences and fermentations; the acid and the alkaline humours mixed and contended together; maladies arofe from the excefs of the one or the other, and the therapeutic art combated them with remedies of a contrary nature. The art of healing was for fome time infected with this error, which was deftroyed only by the rife of experimental philofophy.

4. I attach the fecond epocha to the efforts which fome great phyficians, equally illuftrious by their knowledge of chemiftry, were obliged to make in order to deftroy the abfurd and pernicious afcendancy which the theory of the acids and alkalis had affumed in the art of healing. After the firft fucceffes of experimental philofophy; after the great revolution effected in the fciences by a Bacon, a Newton, and a Boyle, Stahl and Boerhaave occupied

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themſelves with liberating medicine from the errors which hypothetical chemiſtry had introduced into it. They were obliged even to rate its uſe in the art of healing almoſt as an abſolute nullity, in order to combat the predominant theory; they appeared almoſt to deſpiſe the important labours and firſt outlines of Mayow, Boyle, and Hales, who had borrowed from chemiſtry new means for advancing animal philoſophy, in order to repel the noxious invaſions which it had made in the healing art. Their great influence upon thoſe who taught, ſtudied, and practiſed medicine, had all the ſucceſs which they aimed at; and it was believed that chemiſtry could have no other uſe in medicine than that of furniſhing new remedies, or improved modes of preparing them. This ſecond epocha dates from the commencement of the eighteenth century to nearly a third of its duration. The theory of the acids and alkalis was overturned and ſoon forgotten.

5. The third epocha in the hiſtory of animal chemiſtry, dates from the moment when the operation of the phoſphorus of urine, found accidentally in 1677 by Brandt, diſcovered ſome years afterwards by Kunckel, prepared for a long time excluſively in the laboratory of Godfrey Hanckwitz, at London, for all Europe, was taught at Paris by a foreigner, and deſcribed in 1737 by Hellot, in the Memoirs of the Academy of Sciences. This proceſs, though tedious, difficult, expenſive, and diſguſting,

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was the ſignal of the revival of animal chemiſtry, which then was almoſt intirely neglected. Chemiſts began zealouſly to labour upon urine. Margraff found that the *microcoſmic* or *fuſible* ſalt, the phoſphate of ammonia, was the ſource of its phoſphorus; that it did not proceed from marine ſalt, as Stahl had aſſerted; he gave an excellent proceſs for preparing it, by means of the muriate of lead, added to the extract of urine, and which ſerving to decompoſe, without his knowing it, the phoſphate of ſoda, greatly augmented the quantity of phoſphorus obtained: he even found, if not the real difference of theſe two ſalts, yet at leaſt that there were t[illegible]ferent ones in urine. Pott, in 1740 [illegible]nd Scheffer, in 1753, alſo deſcribed the pro[illegible]ties of the fuſible ſalts or phoſphates; Haupt even diſtinguiſhed the phoſphate of ſoda by the name of *pearled ſalt.* Rouelle the elder, who commenced his lectures at Paris about this period, not only ſucceeded in making phoſphorus for ſeveral ſucceſſive years, but began to multiply his reſearches and his products upon the animal matters. In glancing over the proceſſes of his courſe of lectures, publiſhed in 1762, we find that he had cauſed this department of knowledge to make much greater progreſs, than it preſents in the works of his predeceſſors, eſpecially in thoſe of Boerhaave.

6. The fourth epocha in this department of chemiſtry, ſtill ſo new and ſo little cultivated, is pretty accurately fixed by the labours of

Rouelle

Rouelle the younger. Educated for a long time in the ſchool of his brother, poſſeſſed of the notions of this learned chemiſt, accuſtomed eſpecially by long practical ſtudies, to make more exact and more preciſe analyſes than had been made before, diſtinguiſhed amongſt all the chemiſts of his time, by his great and valuable ſkill in diſtinguiſhing bodies, and ſeparating them ably from each other; he particularly occupied himſelf with animal chemiſtry, for which he ſeemed to have acquired a peculiar predilection. He publiſhed ſucceſſively in the Journal of Medicine of Paris, from the year 1773 to 1777, numerous and new inquiries concerning the ſalts of the blood, the water o[illegible]o-pic patients, the human urine, the ur[illegible]e cow and the horſe, compared with eac[illegible]ther, concerning the ſugar of milk, concerning the blood, concerning the fuſible ſalts, and concerning the urine of the camel. He confirmed the diſcovery, made in Italy by Menghini, of the preſence of iron in the blood. All his analyſes, deſcribed with ability and ſimplicity, given without forced applications to medicine, preſented new truths, which diffuſed a light over ſeveral points of animal philoſophy. The phyſicians availed themſelves of them, as well as of thoſe of Citizen Cadet upon the bile, which he proved to be a ſoap, in the year 1766. Bucquet advanced a little further in the art of analyſing the blood. Poulletier de la Salle announced ſome new facts concerning a concrete

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and cryſtalline ſubſtance contained in biliary calculi. The wiſe and reſerved progreſs of all theſe labours, recalled the mind to the advantageous uſe of animal chemiſtry, and the aid which it offered to the art of healing. Succeſsful reſearches were then made into the characteriſtic differences between the chemical properties of animal and vegetable ſubſtances. Several animal acids were diſcovered; and the preſence of the phoſphoric acid in ſeveral of the animal humours was aſcertained. In a word, chemiſts became inſpired with new courage, and this kind of analyſes aſſumed a luſtre which it had never exhibited before.

7. The fifth epocha which I diſtinguiſh, is remarkable for three extremely ſtriking diſcoveries relative to the animal analyſes, made in Sweden during the ſame time that belongs to the preceding, but known ſomewhat later in France. In 1772, Scheele, a Swediſh apothecary, and Gahn, doctor of medicine in the ſame country, diſcovered the phoſphoric acid in the bones of animals, the ſolid matter of which they aſcertained to be phoſphate of lime, and deſcribed means for ſeparating from them theſe ſubſtances, which till then they had not even been ſuſpected to contain. Rouelle the younger, Nicolas de Nancy, Berniard, Poulletier de la Salle, and Macquer, confirmed this diſcovery, and added ſeveral important facts, with regard to the comparative nature of the bones of different animals, and the proceſs of their analyſis.

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This falt has been found amongft the foffils, and afterwards the chryfolite was difcovered to be compofed of it. Scheele announced, in 1776, that the fame falt, the bafe of the bones, exifted in the human urine with an excefs of phofphoric acid which rendered it foluble. In the fame year, and in the fame Memoir, the Swedifh chemift difcovered a particular acid in the calculi of the human bladder. It was then, that by comparing thefe three capital difcoveries with feveral facts of phyfiology and pathology, it became generally acknowledged that chemiftry, treated in this manner, might be applied with great utility to the art of healing, and that fo far from there being any reafon to apprehend the errors which had already endangered its fate, on the contrary, its important applications could no longer be difpenfed with.

8. At the fame time nearly, and confounding itfelf with the preceding, though deferving to be diftinguifhed by its object and its views, is placed a fixth epocha, not lefs important than any of thofe that have been indicated. It is conftituted by the firft data which the pneumatic doctrine, ftill in its infancy, afforded to the chemiftry of animal matters. Lavoifier, while operating in the year 1774, upon the analyfis of the air, afcertained with precifion the ancient, but vague comparifon which had been made between the refpiration of animals and combuftion, and found that it altered the

air

air after the manner of charcoal. Condorcet then gave the name of vital air to the refpirable part of the air. Crawford found in refpiration, and in the air, which is fubfervient to it, the fource of the animal heat. Carminati difcovered that the mephitis, in rendering animals infenfible, deftroyed the irritability of the heart and of the mufcles. Lavoifier was fucceffively led to ftudy, with Citizen Seguin whom he took as the affociate of his refearches, the phenomena and the influence of tranfpiration, and to afcertain that a great analogy fubfifted between this function and refpiration. Citizen Spallanzani at the fame time made a kind of living analyfis of the gaftric juice, and confirmed its diffolvent quality, which had been already proved in 1743 and 1744 by the ingenious Reaumur; he alfo difcovered in it a ftrong antifeptic power. This new career, which, it is evident, deferves to form an epocha in the hiftory of animal chemiftry, has not fince been interrupted. It has diffufed the cleareft light over the phyfical nature of animals, and proved that phenomena, which are truely chemical and appreciable, take place in the exercife of their functions. It is in fome meafure a living chemiftry, which Mayow had a glimpfe more than a century ago, which was purfued in fome points by Hales at the beginning of the eighteenth, and refumed in our time by its relations equally effential and immediate with the principal phenomena

nomena of the pneumatic doctrine which ſtand in ſo natural a connection with it.

9. The ſeventh epocha, which is ſtill more important than the preceding, on account of the greater number of objects diſcovered, or at leaſt illuſtrated, which it includes, and the generality which it embraces, relates intirely to the reſearches of Citizen Berthollet. This illuſtrious chemiſt, after having embraced, in the year 1784, upon the diſcovery of the compoſition of water, for which we are indebted to Lavoiſier and Citizen Monge, the pneumatic theory which appeared to him to be confirmed by this diſcovery, advanced animal chemiſtry a new ſtep forwards, by fixing the nature of ammonia which Scheele had only ſuſpected, and by diſcovering in animal ſubſtances a large quantity of azote. Ammonia being deciſively aſcertained to be a compound of five parts of azote and one of hidrogen. Citizen Berthollet ſhowed how it was formed ſo often by the action of fire, by putrefaction, &c. in animal ſubſtances ſo highly charged with azote. He proved, moreover, that the preſence of the phoſphates, and the abundance of hidrogen amongſt their principles, contributed greatly to this difference. There is eſpecially in this new ſet of data, which we owe to the French chemiſt of whom I ſpeak, and in the epocha which I conſider them to conſtitute, a character by which it ſenſibly differs from the preceding epochas; namely, that this ſeventh epocha pre-

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fents a more general and more complete totality and refult than the others; that it refers not merely to a fingle fubftance or to feveral animal fubftances in particular, but to all thefe fubftances at once; that this inveftigation having afforded a knowledge of the whole mafs of animal compounds, thofe which have followed it have acquired a certainty, precifion, and ftability, which they could not have had without it, as will be proved by the expofition of the eighth and laft epocha of this hiftorical fketch.

10. This eighth and laft epocha comprehends the combination of the labours already indicated in the feventh, and the application, fince become more immediate and more eafy, of the analyfes to the phyfical Philofophy of animals, with the uninterrupted fuccefs of thefe applications, and the real exiftence of a new career, proper for explaining the moft obfcure phenomena of this philofophy, provided it be conftantly purfued. It is efpecially from 1777 and 1788 that this epocha ought to be dated, and it extends to the prefent moment. We find in it new and valuable analyfes of milk and blood by Citizens Deyeux and Parmentier, of the fynovia and of the humour of veficatories by Citizen Margueron, of the liver of cartilaginous fifhes by Citizen Vauquelin, of the human fperm by the fame chemift, of the faliva by Mr. Siebold; the difcovery of a new animal acid, formed by diftillation, and called zoonic acid by Citizen Berthollet. I, in particular, have

have not ceafed, in this laft epocha, to continue, availing myfelf of all the new means afforded by the pneumatic chemiftry, the feries of refearches which I long ago commenced upon almoft all the animal fubftances, for the moft part with the affiftance of my friend and pupil Citizen Vauquelin; I have publifhed a great number conjointly with him; and fome of them are peculiar to myfelf. A rapid enumeration will be fufficient to afford an idea of them; the converfion of bodies buried in the earth into a fatty matter, combined at firft with ammonia, the refemblance of this fatty matter with fpermaceti, and with the lamellated and concrete part of biliary calculi; its generality or its abundance in moft animal fubftances, which has induced me to confider it as one of their moft conftant products, and to defignate it by the name of *adipocire*; the proportion of azotic gas difengaged by the nitric acid from different animal fubftances compared; the exiftence of this gas in the air-bladders of carps; the prefence of gelatin and fometimes of bile in the blood; the concrefcibility of the albumen, owing to the fixation of oxigen, and the varieties of this humour, dependant upon the proportion of this principle; the prefence of the phofphates, and efpecially of that of lime in many of the animal liquids, in which it was not known before, particularly in milk; the abfence of phofphoric acid in the urine of infants; the calcareous benzoate which fupplies the place of the

the phoſphate of lime in that of the herbivorous mammalia; the analyſis of the tears and of the naſal mucus; their catarrhal thickening by the oxigenated muriatic acid; the analyſis of the inteſtinal calculi of horſes, ſince confirmed by Citizen Bartholdi of Colmar; that of the renal and veſical calculi formed by the carbonate of lime, which admits of the lighteſt and weakeſt acids as lithontriptics; the horns, the hair, the tranſpiration of theſe animals, containing and evacuating the phoſphate of lime; the production of the Pruſſic acid by the diſtillation of the human calculi; the ſame, formed in the treatment of all theſe animal matters by hot nitric acid; the inſtantaneous formation of ammonia in all theſe matters treated by the cauſtic alkalis; that of water, when they are treated in the cold by the concentrated ſulphuric acid; the partial decompoſition of the phoſphate of lime by the acids, the formation of the acidulous phoſphate of lime and not the ſimple and pure diſengagement of the phoſphoric acid: ſo that by the proceſſes hitherto given, we do not by far obtain the whole of the phoſphorus contained in bones; a new analyſis of the calculi of the human bladder, which has proved the preſence of four ſubſtances which were not known to exiſt in them, and which ſingularly vary their nature; namely, of the ammoniaco-magneſian phoſphate, of the combination of uric acid with ammonia, of the oxalate of lime in the mural calculi, and of ſilex, the

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moſt rare indeed of theſe calculous matters; the aſcertaining the real ſolvents of calculi, and their neceſſary diverſity according to the nature of theſe concretions; a more profound examination of the human urine, and the diſcovery of the ammoniaco-magneſian phoſphate which is formed in it, as alſo of a particular matter which gives to this liquid its characteriſtic properties, and which I call urée; the medicinal action of the oxigenated ſubſtances, ſo much applied to ſince by ſeveral Engliſh Phyſicians; the preparation of fat ſurcharged with this principle, employed at preſent with ſo great ſucceſs by one of my pupils, Citizen Alyon, who has particularly followed up my firſt views relative to this ſubject, and has carried them very far: ſuch are the principal reſearches in which I have been engaged ſince the epocha when my friend Berthollet, by his important diſcoveries, fixed the progreſs of animal chemiſtry, which till then had been uncertain and wavering.

11. Though this is not the place to ſhow how all theſe labours and diſcoveries have influenced the progreſs of Animal Philoſophy and the art of healing, it will be eaſily conceived, from the ſimple and preciſe ſketch which I have juſt preſented, how many uſeful applications muſt have been derived from their reſults, and what great advantages they promiſe to medicine. It is evident that this is the only manner of determining the differences which ſubſiſt be-

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tween the different animal ſubſtances, of explaining their formation, and the alterations of which they are ſuſceptible; of furniſhing to Phyſiology what the moſt minute anatomy and the moſt exact and multiplied obſervation of what paſſes in living animals could never afford, as theſe two means are ſo ſoon exhauſted. Moreover, theſe firſt data, already ſo important and ſo uſeful, are the fruits of the labours of only a few men. Unfortunately, the number of labourers is very inconſiderable in proportion to the immenſe reſearches which this part of chemiſtry requires, and the multitude of queſtions to be ſolved which it preſents. Scarce a twentieth part of the chemiſts whom Europe poſſeſſes direct their views to this object. What will it be when, having become more univerſally diffuſed, more familiar, and preceded by all the intereſt which they ought to inſpire, theſe grand reſearches ſhall be multiplied; when hoſpitals appropriated to this uſeful inveſtigation ſhall have aſſumed the activity which their importance claims; when the phyſicians ſhall no longer neglect their opportunities of analyſing the morbific matters, &c.

12. It is then that all the hitherto incoherent parts of the new diſcoveries relative to animal chemiſtry will be approximated and linked together, by relations which yet can only be partly foreſeen and ſuſpected; it is then that a monument will be raiſed for which we are as yet only collecting the firſt materials. Some

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persons, indeed have already been too precipitate in making applications of the modern chemistry to the art of healing; they have been too hasty in forming from them a medical system, either of the nature of diseases, or of the employment of remedies. Whatever zeal these first attempts may indicate in their authors, they are, however, to be censured for an exaggeration equally detrimental to both of these sciences, which they have attempted to connect together by premature approximations. They are not, as formerly, chemists properly so called, who have ventured upon this enterprize; these theorists are not those particularly to whom we are indebted for the most connected investigations, the most numerous experiments, the recent discoveries upon the animal matters, who have attempted to form a chemical system in medicine. Rouelle the younger never proposed any thing of this kind; Scheele has only given an account of the particular facts which he discovered; Citizen Berthollet to whom we owe so many and such ingenious labours in this new province of chemistry, has allowed himself only to make some particular applications of them; and if I may be permitted still to quote myself here, after the researches relative to this department of the science, in which I have been incessantly engaged for nearly twenty years past, I have never even attempted to establish a general theory. I am thoroughly convinced that the efforts of chemistry will hereafter change the

the aſpect of medicine, that they will produce a happy revolution in this as well as in all the other departments of phyſics: but this period has not yet arrived, and too many deficiencies ſtill remain for theſe changes to be admitted. I ſhall carefully collect, at the end of this ſection, ſuch important applications as the actual ſtate of chemiſtry permits to be made to animal philoſophy, to which I ſhall at the ſame time ſubjoin ſeveral new proſpects, which naturally preſent themſelves: but ſo far from forming a complete ſyſtem, it will be ſeen that they only prove the neceſſity of continuing our inveſtigations and not relinquiſhing a ſeries of inquiries which will hereafter conduct us to the deſired end.

ARTICLE IV.

Of the General Reſults of the Modern Experiments upon the Animal Compounds.

1. THE labours of the modern chemiſts upon animal chemiſtry have not been confined to adding a more or leſs numerous ſeries of new facts or of inſulated diſcoveries to thoſe which had been made before them; they have more eſpecially conducted philoſophers to general reſults reſpecting the nature of the animal compounds. It

It is even in this circumſtance that the real difference between the epocha of the pneumatic chemiſtry and thoſe which had preceded it conſiſts. Till then the ancient chemical facts preſented neither a general coincidence, nor data that could be applied to all animal matters; they formed truths unconnected with one another; they admitted of none of theſe approximations which really conſtitute the ſcience, and without which it does not exiſt.

2. One of the principal objects of theſe labours has been to examine with attention the analogy announced after Boerhaave between the animal and the vegetable compounds. They have been found to reſemble each other in their complication; they have been conſidered as ſubſtances which, having at firſt been vegetable, have acquired in the bodies of animals, and by their vital powers, a more complicated compoſition. Since that time we have been able to conſider the organs of animals as chemical inſtruments, deſtined for uniting a greater number of principles together than the vegetable inſtruments; provided, however, that they ſhould act upon compounds at leaſt ternary, already previouſly formed in the organic texture of the plants; for obſervations eaſily ſhow that no mineral ſubſtance can be changed immediately into animal matter in the bodies of animals.

3. In order to eſtabliſh this compariſon, which ought, however, to conduct us to the deter-

determination of their differences; after having reprefented the animals as formed, like the vegetables, of immediate principles, in the enumeration of which an extractive matter has been found in the flefh, &c. a gelatinous mucilage in the membranes and the bones, anfwering to the vegetable gum, a fugar of milk anfwering to the fugar of plants, fats reprefenting their fixed oils, refins, particular acids, and the albumen refembling the gluten of flour; it was very natural, immediately after the labours of Rouelle, that we proceeded to confider the animal matters as real immediate materials of vegetables, modified only in fome of their properties.

4. But without entirely rejecting every part of thefe analogies, it was foon found that they ought not to be admitted in too ftrict a fenfe; that they exhibit perhaps more differences than refemblances between thefe two claffes of bodies when compared with each other; that none of thefe immediate materials could be rigoroufly judged to be of the fame nature; that the more attentively they were examined, the more diftinct characters they were found to poffefs; that thus the immediate materials of vegetables which pafs into the bodies of animals fpeedily acquire in them, and by the flighteft exertions of the vital power, properties very different from thofe which they originally poffeffed. Befides which, the different fubftances entering into the formation of the body of ani-

mals were ſubject, as immediate materials, to a more eaſy ſeparation, becauſe they are more inſulated from each other and more diſpoſed to ſeparation, it was alſo found, that ſuch of theſe materials as appeared to be the moſt ſimilar to ſome one of thoſe of the vegetable, nevertheleſs differed from it much more in its intimate nature, and conſequently in the phenomena which is preſented in chemical experiments than had at firſt been imagined.

5. The changeableneſs of the animal matters already verified long ago, announced that their more complicated compoſition was the principal cauſe of it; we began clearly to conceive why they were leſs permanent than the vegetable ſubſtances, why they were decompoſed more eaſily and more ſpeedily, why their changes were more rapid, and why they never remained in the ſame ſtate. The number of their primitive principles being greater, had it been augmented only by a ſingle one more than the three which have been well aſcertained in the vegetable compounds, namely carbon, hidrogen, and oxigen, —the ſingle addition of azote to theſe three firſt conſtituent elements of the vegetable alimentary matter,—an addition produced by the phenomena and the powers of life, is ſufficient to enable modern chemiſts to explain their changeableneſs, by calculating the multiplicity of attractions to which this number of the principles muſt give riſe.

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6. This laſt notion, acquired chiefly from the diſcovery of Citizen Berthollet, conducted me to another not leſs general or leſs important, relative to the animal matter; namely, that when deprived of the azote with which its compoſition is complicated, eſpecially by the action of diluted nitric acid, this matter ſeems to experience a retrogradation, and to return to the ſtate of vegetable matter, ſuch as it had been before it had undergone animalization. It is thus that I eaſily account for the abundant converſion of the animal compound into an acid ſimilar to that which is alſo produced by the chemical art in the vegetable matters; an acid which it affords even in greater abundance than the materials of plants do, as Citizen Berthollet had announced ſome years after the diſcovery of the preparation of the acid of ſugar, or the oxalic acid by Bergman.

7. The complication in the compoſition of animal ſubſtances, which is the common ſource of their differences, and at the ſame time of analogies with vegetable ſubſtances, does not conſiſt merely in the addition of azote but alſo in that of ſulphur and of phoſphorus; theſe three combuſtible bodies, combined with carbon and hidrogen, are the common ſource of the fetid gaſes diffuſed by animal compounds during their decompoſition, by whatever agent it may be effected. The tendency which two of them have to aſſume the form of gas, and that which the three others have to

diffolve together or feparately and in very different proportions in the two former, are the caufes of this fetor, which has always been acknowledged as one of the moft marked characters of the animal fubftances.

8. We muft alfo reckon amongft the important refults afforded by modern chemiftry, relative to the compofition of the animal fubftances, and their general differences, the prefence of the phofphates fo accurately eftablifhed by Scheele, by Citizen Berthollet, and by my own inveftigations concerning thofe fubftances. It will foon be feen, not only that thefe falts form fometimes nearly the whole texture of feveral organs, that they give a more or lefs marked character to fome of the liquids of animals, but alfo, that they act an important part in the chemical phenomena which both prefent to the obferver; and that they give rife to fome of the principal properties which are difcovered in them by analyfis. In this abundance of the phofphates, confifts one of the moft ftriking differences prefented to the chemift by the animal compound compared with the vegetable.

9. Laftly, we ought to refer to the totality of the modern difcoveries, and to the new analyfis of animal matters,—we ought to rank amongft their moft valuable refults, the knowledge which they have afforded concerning the proportion, or the relation of quantity, between the conftituent principles of thofe matters. Without this knowledge all the reft would be

barren,

barren, it is this which fecundates it by rendering it complete. It has been found that animal matters contain more hidrogen and lefs carbon than the vegetable, more fulphur and phofphorus, more phofphates with different bafes than the vegetable compounds; and that the converfion of the latter into the ftate of animal compounds does not confift merely in the addition of fome principles and the complication of their compofition confequent upon this addition, but alfo in the change of the proportion of thofe principles.

10. Thus the general refult of all the various labours upon the animal analyfis, that which includes all the other particular refults, which gives rife to them, and which is their common fource, fhows that animal matters are compounds, at leaft quaternary, formed by the union of hidrogen, of carbon, of azote, and oxigen, with which are frequently affociated, in very variable proportions, fulphur, phofphorus, lime, magnefia, and foda. Thefe compounds, lefs carbonated but more hidrogenated than the vegetable fubftances, are brought to the ftate of oxides by the oxigen they contain. The proportion of hidrogen in them being more confiderable, the azote being very abundant, the phofphorus and the fulphur frequently uniting in them their particular attractions, there refult from them, matters more or lefs combuftible, eafy to be decompofed, very alterable, very fetid in moft of their alterations, very

very much inclined to aſſume the oily character, and to furniſh ammonia. Theſe are the truths well eſtabliſhed by the new diſcoveries; and all that will follow this general expoſition in the preſent ſection will be only a development or application of theſe doctrines.

SECOND ORDER OF FACTS.

Of the Chemical Properties or Characters of Animal Subſtances in General.

ARTICLE I.

Of the General Conſideration of this Order of Facts.

1. IT is not ſufficient to have enunciated in the preceding article the general nature of the animal compounds: to know what they are formed of in general, gives indeed a notion of their difference from vegetables, and of their particular mode of exiſtence; but this notion can only be conſidered as an introduction to their chemical hiſtory, or as a firſt means of arriving at the expoſition of the latter. It conducts us to it without being able to ſupply its want; it may precede it, but it cannot be ſubſtituted in its place. When once well conceived, it leads to the underſtanding of the real chemical properties of animal matters; but alone it will never conſtitute them; it muſt even demand that we ſhould paſs from the general conſideration of this compoſition to the exhibition of the properties of the animal matters.

2. In

2. In fact, when we know the nature of the principles which enter into the compofition of the animal fubftances, we may explain the phenomena which they prefent when placed in contact with different other matters; and it is thofe phenomena, and their manner of comporting themfelves with the different agents by which they are treated, that conftitute the chemical properties of thefe fubftances. There are two methods of confidering thefe properties: we may either treat of thofe that belong to the totality of thefe fubftances, and are found in all in a more or lefs remarkable degree, or we may occupy ourfelves with thefe properties with relation to individual animal matters; and thefe contain the characters which diftinguifh each of them in particular. The firft conftitute the object of this fecond order of facts: the others fhall be examined in the third order.

3. As to the properties of the firft kind, or thofe which belong in general to all animal fubftances, only a very fmall portion was formerly known of thofe which have been difcovered within about twelve years paft; chemifts occupied themfelves with fcarcely more than one of the products obtained from them by the action of fire, and the phenomena which their putrefaction exhibited; namely, the production of what was called *volatile fpirit* and *volatile falt*, and which, as we fhall foon fee, is only carbonate of ammonia by diftillation. It was only by this character that animal fubftances were then

then diftinguifhed from the vegetable; but fince the modern difcoveries there exifts a much greater number of diftinctive characters; for the mode of action of moft bodies upon the animal fubftances furnifhes as many characters proper for diftinguifhing them.

4. Though thefe general properties may now be very much multiplied, and divided into as many fpecies as there are bodies that act differently upon the animal matters, it is eafy to refer them to a certain number of heads, which I reduce into nine articles.

In the firft, I fhall treat of the action of caloric upon thefe fubftances.

In the fecond, I fhall examine that of the air.

In the third, that of water.

The fourth fhall have for its object the action of the acids.

The fifth, that of the alkalis.

To the fixth will belong the properties which animal fubftances prefent with the falts, and the metallic oxides and folutions.

To the feventh I fhall refer thofe which arife from the action of the vegetable fubftances.

In the eighth I fhall examine the acidifiable property of animal fubftances, and the principal acids which they afford, efpecially the Pruffic acid.

Laftly, the ninth article fhall be appropriated to the examination of putrefaction.

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It muſt be evident that theſe nine titles comprehend the action of all the claſſes, or all the genera of bodies upon the ſubſtances with which I am engaged, and that ſuch a diviſion can leave nothing to be deſired relative to their general and characteriſtic properties.

Article II.

Of the Properties derived from the Action of Caloric upon Animal Subſtances in general.

1. CALORIC acts upon the animal ſubſtances by decompoſing them more or leſs rapidly, by changing the combination of their principles, by ſeparating from them products which did not exiſt as ſuch in theſe matters. This general action ſo far reſembles that which this agent exerts upon the vegetable ſubſtances; it reſembles it by tending alike to their deſtruction, by inſulating their principles, by uniting them in another order, by deſtroying the homogenous compoſition of which they were formed. But the analogy ſoon diſappears in a great meaſure, when we examine with attention what paſſes in this ingenious decompoſition; the phenomena are extremely different, and the greater complication of effects which take place are adapted to throw the greateſt light upon

upon the nature of their primitive compofition itfelf. The difcoveries to which the attentive obfervation of this phenomenon has given rife, and the influence which they have had upon our knowledge of the animal matters, are among the moft happy and moft ufeful refults of the modern chemiftry and the pneumatic doctrine, to which we are indebted for thefe difcoveries.

2. Though the action of a mild heat, and the introduction of a fmall quantity of caloric into the animal matters, is in general confined, as with the vegetable matters, to thickening their liquids, giving them the concrete form, drying their folids, extracting from the one as well as from the others, a more or lefs confiderable quantity of water, as it is obtained on the water-bath; yet this action, feeble as it is, prefents very remarkable differences, which become diftinct characters of animal fubftances. A gentle fire tends to coagulate thofe that are liquid, and this coagulation is accompanied with opacity and a change of nature; this is announced by the change of tafte, and by the infolubility in water which thefe coagulated matters acquire. The water, which is difengaged on the water-bath, is in part contained in thefe matters, and in part formed by the action of the fire; it has a particular faint tafte; it contains fome matters which give it the property of becoming turbid, of depofiting flakes, and of putrefying much more

more ſtrongly and quickly than that which is obtained from the vegetables. The animal ſolids, if heated not very violently, experience a change of colour, of conſiſtence, of tenacity, of ſmell, and of taſte, which is known by the name of *baking*, and proceeds from a commencement of alteration which has not yet been exactly determined.

3. The difference of the action of caloric is much more conſiderable, when we expoſe the animal compounds to a more active fire, and to the contact of combuſtible ſubſtances in the ſtate of inflammation or ignited to redneſs. We ſee theſe ſubſtances become agitated, contorted, and bend themſelves in different directions, ſo as to exhibit a remains of irritability, or mobility, to this decompoſing ſtimulus; we might ſay, that, though dead, they ſtill oppoſe ſome reſiſtance to their deſtruction. When this almoſt convulſive ſtimulus has abated, the ſubſtances thus heated with a naked fire, and in an open apparatus with the contact of the air, become ſoftened, or melted, ſwell, exhale an abundant vapour, or ſmoke, of a white, yellowiſh, or reddiſh colour, which diffuſes a fetid ſmell known to every one, and greatly differing from that perceived in the vegetable matters when treated in the ſame manner. Almoſt always an ardent and lively flame ſucceeds theſe firſt effects, and the reduction into coal or aſhes, more or leſs coloured, which terminates them, leſs ſpeedily and leſs eaſily than happens in the vegetables,

tables, indicates the preſence of an oily ſubſtance, whatever the animal body may originally be which is treated in this manner.

4. When animal compounds are heated in a retort of luted glaſs or porcelain, to which is adapted a receiver, provided with a pneumato-chemical apparatus, we at firſt obtain a more or leſs abundant quantity of water, according to the liquid, ſoft, or viſcous ſtate of theſe compounds. This water ſoon comes over brown and turbid; it contains different ammoniacal ſalts; it is ſoon accompanied with carbonate of ammonia, which diſſolves in it at firſt, and afterwards cryſtallizes upon the neck of the retort and the ſides of the receiver. This ſecond product is ſucceeded by oil, which becomes more coloured and conſiſtant towards the end of the operation; whilſt it paſſes no water is diſengaged, or but very little. The oil is accompanied with carbonate of ammonia, which continues to be ſublimed, and part of which is melted and diſſolved by the very hot oily vapour. At the ſame time gaſes more or leſs abundant are developed, and collected in the bell-glaſſes, which terminate the apparatus: if we cauſe them to paſs through lime water, or the metallic ſolutions, or the oxigenated muriatic acid, they precipitate the firſt in chalk, the ſecond in coloured ſulphurets, and they depoſit drops of oil and coaly powders in the third. When the retort which is employed in this operation

operation is heated to fuch a degree as to become ignited at the bottom, we no longer perceive any thing difengaged, either in the aërial, liquid, or folid form; the white vapour which fills the apparatufes of the receivers diminifhes and is condenfed, even though the fire be very violent. The fire is then put out, and the veffels are left to cool; they are afterwards unluted, and the products are examined after they have been feparated, either by their different place in the veffels of the apparatus, or by pouring them into a funnel, where each affumes a pofition relative to its fpecific gravity. Thus are obtained coloured water, concrete volatile falt, animal oil, gafes and coal. Each of thefe products merits a particular examination.

5. The water, as I have already announced, varies in quantity according to the ftate of the animal matter. It is, however, here fuppofed to proceed from a dry matter; for liquids are treated on the water-bath, and coagulated, or infpiffated before they are treated in the retort. This water was not contained intire in the animal matter, but a great part of it is formed, as I fhall fhow hereafter. Here we fpeak only of its nature. Its colour, which is red, or yellow, or brown, its fetid fmell, its acrid tafte, its turbid ftate, prove fufficiently that it is not pure water. When it is diftilled with a double heat, or rectified, though carbonate of ammonia is frequently feparated from it, it generally

nerally paſſes more clear, and even tranſparent. When it is treated with lime, ammonia is diſengaged; with the metallic ſolutions it renders them turbid and precipitates them; with the phoſphoric acid, after the lime, and by ſubmitting it to ſolution, a particular acid liquor is obtained, which Citizen Berthollet has diſcovered to be a new acid, and which he has termed the *zoonic acid*. In a word, we find in it an ammoniacal ſoap which colours it, and ſeveral ammoniacal ſalts which may exiſt to the number of five different ſpecies; namely, muriate of ammonia, and carbonate of ammonia, which we already know; zoonate of ammonia, pruſſiate of ammonia, and ſebate of ammonia, which I ſhall deſcribe elſewhere as particular animal ſalts. Theſe five ſalts are not conſtantly found in the liquid product of the diſtillation of all the animal ſubſtances; but it always contains carbonate of ammonia and ammoniacal ſalt. There are ſome animal matters which, after fermentation, yield ammoniacal acetite, inſtead of carbonate, or at the ſame time with the latter. It is evident that this very complicated product, which was formerly called *volatile animal oil*, and was employed in medicine, was then very little known, and that its ſingular nature was not ſuſpected.

6. The concrete and cryſtallized volatile ſalt, which is obtained of ammoniacal carbonate more or leſs ſoiled by empyreumatic oil. The ammonia is here a product of the fire; it does not

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exiſt previous to its action in the greater number of animal ſubſtances. It has already been ſeen that its production has long been conſidered as the principal diſtinctive character of thoſe ſubſtances; but its ſource has only been known ſince the diſcovery of Citizen Berthollet, relative to the nature of this alkali, which is compoſed of five parts of azote, and one of hidrogen. It is evident that it is formed by the immediate union of theſe two principles, at the time when the greater part of the water already formed, leaves free hidrogen, and when a very high temperature augments the attraction of the oxigen for the carbon. Accordingly, there is produced at the ſame time carbonic acid, which ſaturates this volatile alkali. This ammoniacal carbonate is rectified by ſubliming it with a gentle fire. The formation of the three other acids frequently alſo accompanies that of the ammonia, which in part unites with them; and this formation is owing to the combination of three ſimple combuſtible baſes with oxigen, as I ſhall explain elſewhere. Formerly great virtues were attributed to this more or leſs oily carbonate of ammonia; it was believed that it carried off from each animal matter from which it was obtained, ſome principle which gave it particular characters: ſuch was that of the viper, of hartſhorn, &c. At preſent it is known that it is one and the ſame, from whatever matter it has been extracted. We ſhall ſee hereafter, that though all the animal

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matters equally furniſh this product, they greatly differ from each other with reſpect to the proportion in which they afford it. It is alſo to be remarked, that ſome of the immediate materials of plants, eſpecially the extract, the tanin, the gluten, &c. and ſome entire plants, amongſt which are to be diſtinguiſhed the cruciferous, the papaveraceous plants, the funguſes, the nitrous plants in general, yield carbonate of ammonia in diſtillation, and that this property, which they owe to their containing azote amongſt their principles, was the reaſon why they were called in the ſchool of Rouelle by the not improper name of *animal plants*, though it was not known in this ſchool from what ſource that product proceeded.

7. The oil obtained in the diſtillation of the animal matters was no more contained in theſe matters than the ammonia which is volatilized from them; it is equally a product of the action of caloric upon their principles. It is formed at the time when a large portion of the oxigen of theſe matters, abſorbed by the hidrogen to form the water which paſſes over firſt, leaves in the reſiduum a greater proportion of hidrogen which approaches this reſiduum to the oily ſtate. This oil differs from that which the vegetables, treated in the ſame manner, afford, by its abundance, its thick, concrete ſtate, and its ammoniacal nature; it turns the blue vegetable colours green; it has a fetid and very tenacious ſmell. Dippel, a chemiſt of Berlin,

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was the first who rectified this oil for medicinal use: it has therefore been called by his name. This rectification consists in distilling it with a mild heat, not exceeding the temperature of boiling water, and which is still better, from this liquid itself introduced into a retort with the oil, as Rouelle has recommended. The rectified animal oil is white, very liquid, very odorous, and very volatile; it is quickly turned yellow and brown by the contact of the air, and the light. Carbon which colours it, is separated from it.

8. The gases which are disengaged from animal matters treated in the retort, which Hales had considered to be air, and which induced him to assert that this principle was the cause of their solidity, because at the moment when they escape, these matters generally lose their coherence, are mixtures of carbonated hidrogen gas, frequently sulphurated, and even phosphorated at the same time, and carbonic acid gas. They are very fetid, very combustible, and they frequently burn with an oily flame: to these is owing the infected odour diffused by the animal matters which are burned in the air, or which are distilled in ill-closed vessels, as well as when the vessels in which their products have been received are unluted. When these gases are kept for a long time under water, it becomes turbid; there is frequently deposited upon the sides of the vessel a carbonous and sulphureous crust, of a blackish brown

brown colour; frequently alſo, we perceive drops of a thick brown oil, precipitated and attached to the glaſs; which proves that theſe gaſes carry off a portion of this body in ſolution. If we make them paſs into lime water, they precipitate it in calcareous carbonate; in a nitric ſolution of lead, they form a blackiſh brown precipitate; when they paſs into oxigenated muriatic acid, carbon is ſeparated and precipitated in the liquor. They have been examined and analized by detonation with oxigen gas in Volta's eudiometer, after the carbonic acid had been ſeparated from them by a cauſtic alkaline ley. It was in this manner that Citizen Berthollet aſcertained their nature.

9. The coal which remains in the retort after the diſtillation of an animal matter, very rarely retains the primitive form of this matter; for it becomes ſoftened, fuſed, and ſwelled by the action of the fire. It is more denſe, more ſolid, and adheres more firmly to the glaſs than that of the vegetable ſubſtances; frequently it even forms one ſubſtance with the retort, ſo that its weight cannot be aſcertained, unleſs the veſſel has been weighed previous to the operation, and weighed again at the termination of the proceſs. Its proportion is in general leſs than that of the vegetable coals; it is rarely or hardly ever inflated or cavernous, at leaſt unleſs an albuminous or ſaponaceous liquid has been diſtilled; in the latter caſe alſo, we frequently find only a coally layer,

layer, which occupies more ſpace in the retort. Sometimes the animal coal is brilliant, of a metallic appearance, and it is then found very analogous to the carburet of iron. Its combuſtibility is in general very ſlight; it muſt be kept at a ſtrong red heat, and agitated for a long time in contact with the air, in order to reduce it into aſhes; it is not ſeen to burn ſenſibly, and become covered with a layer of aſhes, like that of the vegetables. The ſtrong fire neceſſary for its incineration, frequently changes the nature of its reſiduum and volatilizes a part of its ſalts. Soda and muriate of ſoda are diſengaged from it; the phoſphates which it contains are vitrified. Accordingly Citizen Berthollet, in order to analyſe the animal coals, has employed nitrate of pot-aſh, by cauſing them to detonate in veſſels proper for collecting the elaſtic fluid products, and the pulverulent reſidues. I have employed the ſuper-oxigenated muriate of pot-aſh for the ſame purpoſe. This character of incombuſtibility, which ſo eminently diſtinguiſhes the animal coals, proceeds from the little carbon which they contain, the denſity which it preſerves in them, its union with the phoſphates of ſoda and of lime, and the oxides of iron and manganeſe, which invelop and condenſe it.

10. All the effects of fire upon the animal matters, which I have juſt deſcribed, all the products which I have examined, prove that caloric, by changing the nature of theſe matters, and making a complicated analyſis of them,

them, combines their conſtituent principles in another order, and that finding them more numerous than thoſe of the vegetable ſubſtances, it gives riſe to a greater number of new compounds. Water is formed in them leſs abundantly, oil in larger quantity; ammonia, eſpecially in conſiderable quantity, excluſively belongs to them; the acids which unite with them, all announce, like the ammonia, an abundant ſource of azote. Leſs carbonic acid, and more hidrogen gas than in the products of vegetables, indicate a ſmaller proportion of carbon, and a larger of hidrogen in the animal ſubſtances. The ſulphur and the phoſphorus which modify their gaſes, announce the preſence of theſe two combuſtibles in theſe ſubſtances. This ſeries of the effects of fire, and of the products to which it gives riſe, proceeds, therefore, from the primitive complication of the animal compounds, from the multiplied action of their principles upon one another, and from the more numerous attractions which they reciprocally exert. None of theſe effects of caloric, which are very well adapted for elucidating the nature of theſe compounds, though they were formerly believed to be very obſcure and almoſt inexplicable, is at preſent attended with any real difficulty, and it is one of the fineſt reſults of the pneumatic chemiſtry, to have afforded a clear and eaſily intelligible explanation of them. It has been able to derive great advantage from what had long been only a ſource of errors and of obſtacles to its progreſs.

ARTICLE

Article III.

Of the Properties of Animal Matters treated by the Air.

1. THE properties which the animal matters prefent, when expofed to the contact of the air, and by the effect of this expofure itfelf, are lefs general and lefs conftant than thofe which are produced in them by the action of fire; they vary much more amongft themfelves, according to the differently modified nature of thefe matters, than the preceding. In general, thofe which are folid undergo very little alteration, or a very flow alteration by the contact of the air; the liquid animal fubftances are almoft exclufively and much more fenfibly changed by the impreffion of the air; and it is according to thefe changes that I fhall here announce the properties of thefe matters, referring them to a certain number of general heads.

2. I find fix different effects produced by the air upon animal fubftances, independant, indeed, of thofe which it can produce in the living animals; for the general characters of the fubftances which I examine are taken more efpecially in their dead ftate; the vital motion caufes them to vary, or renders them complicated, and we muft firft determine what takes place

place in them without the vital principle which animates them, before we can treat of the phenomena which accompany their living ſtate. Theſe ſix effects refer 1, to the abſorption of oxigen; 2, to the concretion which it produces in them; 3, to the colouration to which it gives riſe; 4, to the ſlow combuſtion which it excites in them; 5, to the alteration which it experiences itſelf; 6, finally, to the decompoſition which they ſuffer by the internal motion which it excites in them. I ſhall recapitulate each of theſe effects in ſucceſſion.

3. Almoſt all the animal liquids have the property of abſorbing the atmoſpherical oxigen gas; thoſe which are viſcid, gluey, or ſaponaceous, poſſeſs it in a pretty high degree. This is proved by leaving them expoſed to the air in inverted jars, ſuffering them to elevate themſelves in theſe veſſels, and afterwards examining the reſidual gas by the endiometrical proceſſes. We find that it contains much azote gas, and that it is ſometimes even reduced to this gas in a pure ſtate, when the expoſure to the air has been long continued. The abſorbed gas remains ſimply condenſed, and particularly combined for ſome time: accordingly, the oxigenated liquids ſwell conſiderably in vacuo or by the action of heat. Gradually the oxigen becomes more ſolidly fixed, combines intimately with them, and changes their nature by oxiding them more than they were before.

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4. The concretion of the animal liquids consequent upon the abſorption of oxigen is eaſy to be obſerved, and leaves no doubt of the exiſtence and reality of this ſecond effect in the white of egg, the ſerum of the blood, the water of hydropic patients, &c. expoſed to the air. We ſee flakes formed in the liquids, remain ſuſpended in them, and become precipitated. By agitating the liquids in the air, they acquire ſuch a diſpoſition to concretion, that a part becomes ſolid. In this manner are formed the factitious membranes known at Cos, more than a thouſand years ago, and deſcribed by Hippocrates. The aërated water produces the ſame effect by its mixture and agitation with theſe liquors. White of egg expoſed to the air, or eggs that have been kept for ſome time, boil and harden much more eaſily than very freſh eggs. This phenomenon is connected with the formation and the regeneration of the epidermis; it explains the *plaſtic powers* of the ancients; it ſubſtitutes a ſimple phyſical fact inſtead of an occult quality; it preſents itſelf in the mechaniſm of nutrition.

5. A thouſand phenomena prove the colouration produced in the animal ſubſtances by the contact of the air and by the ſlow abſorption of oxigen. Even the ſolids are not exempted from this conſtant effect. Bones and ivory become yellow, the ſkin turns brown and black in the air; the blood reddens in it and aſſumes the bril-

brilliant purple colour which characterizes it, whilſt that part of it which is deprived of the contact of the air remains of a dark, and almoſt black colour. The white albuminous and gelatinous liquids become yellow; fats acquire a citron or orange-colour; wax and ſpermaceti become yellow; the colours of the kermes, cochineal, ſeveral worms, and ſome molluſcæ acquire their greateſt luſtre by the contact of the air; the bile, the urine, and the perſpiration acquire a more intenſe colour in the atmoſphere; the white diſcharges from the noſe, the lungs, the urethra, from ulcers, become yellow or green; all the marine animal products become darker-coloured and browner when they are taken out of the water and placed in the air; putrefaction is accompanied, and its periods are marked by many different tinges.

6. The firſt effects which have juſt been enunciated, whilſt they indicate a remarkable attraction between the animal matters and oxigen, ſhow pretty clearly that they repreſent a kind of ſlow combuſtion, which cauſes them to paſs into the ſtate of oxides, and which, in ſome caſes, though indeed rarely, gives them even the character of acids: it is in this manner that the acetous acid is produced in ſeveral ſubſtances expoſed to the air, eſpecially in milk and urine. The diſpoſition to coagulation by the fire, or to ſpontaneous concreſcibility, correſponds with the ſolid and concrete form which the

the oils assume when they are exposed to it, and represents a real oxidation which has its limits and its termination, at the point when the animal matter which experiences it is saturated, and can no more absorb a larger proportion of oxigen. This analogy with the concrescibility of the vegetable oils authorizes us to consider the animal compounds as approaching to the oily character, or very much disposed to assume it.

7. The four phenomena that have been enunciated do not take place without the air itself undergoing a change, a more or less considerable alteration. When an animal matter has been for some time exposed to it, we find this air less charged with oxigen, more saturated with water, containing much carbonic acid, and infected with a disagreeable smell. These four changes correspond with four kinds of effects produced by the animal substances; they immediately absorb a portion of the atmospherical oxigen; their hidrogen burns rapidly and forms water; their carbon destroys also a portion of the oxigen gas, which dissolves and acidifies it; finally, a portion of the animal matter itself, already much altered and corrupted, or at least the sulphurated, phosphorated and carbonated hidrogen gases which are disengaged from it, give the air a very marked character of fetidity. Thus, we conceive the cause of the infection and of the noxious properties which the air acquires in the chambers

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of ſick perſons, in hoſpitals too confined, &c. and perhaps even the manner in which certain fevers, &c. are communicated.

8. In proportion as animal matters abſorb the atmoſpherical oxigen, they become diſpoſed to concrete, become coloured, experience at firſt a ſlow real combuſtion, and at the ſame time pour into the air different principles which change its nature, and thus theſe ſubſtances ſenſibly proceed towards that ſpontaneous decompoſition which tends to deſtroy them, or to reduce them to more ſimple, namely, binary compounds. We ſee them from day to day vary in their conſiſtence, their colour, and their ſmell; fetid effluvia and gaſes are diſengaged from them; their volume is changed, their principles exhale; there is formed in them water, carbonic acid, ammonia, or nitric acid; in a word, they ſuffer an inteſtine motion which deſtroys them, ſeparates a portion of them in the gaſeous form, and leaves a part of their fixed reſiduum in the ſtate of mould. Putrefaction, one of the moſt marked characters of the animal compounds, one of the phenomena that moſt deſerve to be ſtudied with attention, will be deſcribed in one of the ſubſequent articles. I have indicated it here only in order to exhibit the ſeries of the effects of air upon theſe ſubſtances; for the contact of air favours and accelerates it.

9. If we compare the ſix effects here indicated, we find as the reſult, a great alterability in the

animal

animal fubftances; we perceive that this refult refembles that of the action of fire, that it depends upon the complicated compofition of thefe fubftances, the number of primitive principles which conftitute them, the multiplied attractions which they exert upon one another, and even the flightnefs of the caufe required in order to bring all thefe attractions into play. We alfo fee compounds formed in them, as to the greater part of their mafs, of combuftible bodies, having in the totality of their compofition, as well as in each of their principles in particular, a great tendency to unite with oxigen, abforbing it at firft in their entire ftate, diffolving in it afterwards into their elements which become feparated, and thus experiencing fucceffive changes which gradually conduct them to their total decompofition. The remarkable difference of the volatility of fome of thefe principles and the fixity of fome others, alfo renders this general theory more certain and more eafy to be conceived. We fhall find it more and more ftrengthened and confirmed in the fubfequent articles.

Article IV.

Of the Action of Water upon Animal Substances, and the Characteristic Properties to be derived from this Action.

1. THOUGH we have had frequent opportunities of examining the action of water upon animal substances; though the experiments upon this action are very numerous, even in domestic economy and in many of the arts, we not yet possess all the knowledge which it might be expected to furnish respecting their nature, nor have all the characters proper for distinguishing them from the vegetable matters been derived from it. There are, however, some which are sufficiently marked and prominent to establish important distinctions between these two classes of beings, and these I shall at present show.

2. Cold water penetrates the most solid animal matters by mere contact: it separates their fibres and their laminæ or plates; it renders their texture more perceptible by thickening and distending it; it tends to separate their fasciæ or their layers, and in this point of view, it is employed by the anatomist when he wishes to proceed further in the investigation of their structure than the scalpel and the most careful dissec-

tion

tion can load him. There are ſome animal matters which are always found diluted with water, liquefied by it, and owe to it their ſtate, as well as that mobility which permits their tranſportation into different parts of the bodies of animals. Moſt of the animal liquids are eaſily miſcible with water; and if we except the ſolids, all the animal parts are ſoluble in this liquid.

3. When we cauſe hot and boiling water to act upon animal matters, there are ſeveral which, though inſoluble in this liquid when cold, diſſolve in it eaſily and quickly by means of that activity which the caloric communicates to it. Such are moſt of the white membranous textures which melt in boiling water, and afterwards form jellies with it by cooling, and glues by evaporation; it is on this account that theſe textures are called *gelatinous* in chemiſtry. When we give to the water, by compreſſion in Papin's digeſter which prevents its evaporation, a much higher temperature than that of boiling water, we at laſt ſoften even the bones, and cauſe them to aſſume the gelatinous ſtate. The corneous and cartilaginous textures paſs into this ſtate ſtill more eaſily and quickly.

4. There are ſome animal liquids, analogous to the white of egg, and on that account called *albuminous*, which ſuffer by the action of hot water below 48 degrees of temperature, a coagulation, an induration, and an opacity with which every

every one is acquainted. This property, which is oppofite to the gelatinous folubility, announces, in the fubftances which are fufceptible of it, a very different nature, and it has defervedly occupied much of the attention of chemifts and phyficians. Whilft the latter have defcribed it as a particular and living power, which they have called *plaftic*, the former have difcovered that it depends upon the oxigenated ftate of the animal liquids, or at leaft that it is confequent to this ftate; that it is owing, as I have fhown in the preceding article, to the intimate combination, the fixation of this principle.

5. That effect of hot water upon the infoluble animal folids which is the moft generally known, is the boiling of meat. Chemifts, however, have not yet accurately determined the mechanifm of this effect. It is known that there is produced by it, in the boiled fubftances, a diminution of their tenacity, a change of texture, of colour, of tafte and fmell, which renders them agreeable to the organ of tafte and eafy of digeftion. It appears that the coction or boiling confifts in a change of proportion and of ftate in the animal compofition, the fufion of the gelatine, the coagulation of the albumen, and a kind of maceration of the fibrous organization, which renders them eafy to be bruifed by the teeth, and reduced into a foft and ductile pafte by maftication. This property is very different from the coction which the vegetable

 fub-

fubftances undergo, and the change which the latter fuffer is very diftinct and lefs fenfible to every one. Many vegetable matters may be ufed as food in their crude ftate, but the civilized part of the human fpecies cannot eat raw animal fubftances.

6. Long maceration in water changes alfo the texture and the nature of animal fubftances in a manner fo different from the effect it produces upon the vegetables, that we muft thence derive a very decifive character for eftablifhing a well marked difference between thofe two claffes of organic compounds. Almoft all the animal matters, when immerfed in water, become converted into a fatty fubftance, analogous to fpermaceti, which I have already indicated by the name of *adipocire*. Ammonia at the fame time formed, which is diffolved, and carbonic acid which exhales. It is known that in like circumftances the vegetables blacken and become carbonated. This phenomenon, in the animal matters, depends upon their putrefcibility; and it is fufficient here to mention it, fince its caufe and its refults will be treated in a more explicit manner in the article concerning putrefaction.

7. It is evident from thefe effects of water upon the animal compounds, that the general caufe which determines their differences from that which the vegetable matter fuffer, depends upon the more complicated compofition of thofe bodies. It is always the fmaller propor-

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tion of carbon and of oxigen, and the larger of hidrogen and azote, which give rife to the changes that have been mentioned, and the phenomena that have been defcribed. Thefe changes are more numerous, more varied, and more confiderable, becaufe they take place in fubftances, the conftituent principles of which are more multiplied, and obey a greater number of attractions at the fame time; it is becaufe they take place in fubftances, the equilibrium of whofe compofition, is much more eafily difturbed than that which exifts in the lefs complicated vegetable compounds.

In this fimple explanation we perceive a coincidence which always obtains, between the confequences of the action of water and the effects of the other agents that have been ftudied in the preceding articles. This coincidence will alfo be perceived in all the fubfequent articles.

ARTICLE V.

Of the Action of the Acids upon Animal Subftances, confidered as a Character of thefe Subftances.

1. THE manner in which the acids act upon the animal fubftances, furnifhes chemifts at prefent alfo with a means of characterifing thefe compounds and appreciating their nature.

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The ſcience has made great progreſs with reſpect to the knowledge of this action ſince the eſtabliſhment of the pneumatic doctrine; and in particular it owes much to the labours of the French chemiſts, eſpecially thoſe of Citizens Berthollet, Vauquelin, and myſelf. There are two principal conſiderations to be preſented relative to the action of the acids; the one belongs to all theſe bodies, and is general amongſt them; the other is relative to each of the acids in particular, and differs according to their peculiar nature. I ſhall follow this two-fold manner of conſidering them.

2. All the ſlightly concentrated acids preſerve animal matters and guard them againſt putrefaction; accordingly, they have always been conſidered as powerful antiſeptics, and they have been placed at the head of theſe medicines. All of them have alſo the property of coagulating and thickening the albuminous liquids, of rapidly diſſolving the gelatinous and membranous organs, of preſerving the fluidity of the liquids of the ſame nature, and of preventing them from concreting by refrigeration, as they are accuſtomed to do when alone; they alſo ſoften and diſſolve, with the aid of heat, the fibrous organs, or thoſe which contain in their texture the matter which is called *fibrine*. This ſolution frequently aſſumes the tremulous and gelatinous form. They diſſolve and in part decompoſe the ſolid animal ſubſtance, and change its phoſphate of lime into acidulous

lous falt. Laftly, all the acids, when left for a long time in contact with moft of the foft membranous, or fibrous animal compounds, alter them in the courfe of time, convert a part of them into ammonia, and are afterwards found more or lefs faturated with this alkali.

3. The particular action of each acid is determined by its own peculiar nature; it is in general more powerful and more capable of decompofing animal matters, in proportion as the acid itfelf is more feeble in its intimate compofition, and as its radical adheres lefs ftrongly with the oxigen. There are fome alfo which, without being fo eafily decompofed, act upon thefe matters merely by their acid power. This action varies befides according to the ftate of concentration of each of thefe acids,—according to the quantity of acid placed in contact with the animal matters,—according to the more or lefs folid or foft ftate of thefe matters; and laftly, according to the temperature by means of which we caufe them to act reciprocally upon one another. Amongft the different acids which exert an influence more or lefs evident, and confiderably different upon the animal compounds, we muft particularly diftinguifh the fulphuric, the nitric, the muriatic, and the oxigenated muriatic acids: they comprehend all that need be confidered as to this particular action; for the others, and efpecially the phofphoric, the acetous, the nitric, the tartarous, and the oxalic, fingularly refemble the

muriatic.

muriatic. It muſt not be forgotten that the four firſt, taken in a diluted ſtate, exert only the general actions which have been indicated above.

4. There was formerly obſerved in the manner in which the ſulphuric acid acts upon animal matters, the ſoftening which they expeience, with the more or leſs intenſe colouration they undergo: and it was believed that this effect announced a kind of ſemi-combuſtion beyond which nothing was apprehended: it was compared with the action of fire. Citizen Vauquelin and myſelf, on examining the phenomena of this action, diſcovered that the ancient notion was erroneous, and that there takes place between theſe ſubſtances a ſeries of attractions which change their nature in a very different manner than had been imagined. When we immerſe an animal matter, fleſh, for example, white of egg, or coagulated blood, into concentrated ſulphuric acid, and leave theſe two bodies to act ſpontaneouſly, we firſt ſee the animal matter aſſume ſucceſſively the fawn, the red, the brown, and the black colours, become ſoftened, divided, diſſolved, and form a kind of paſte. The mixture becomes heated; nothing is diſengaged; and on examining it after the action is terminated, we find ſulphuric acid weakened with water, which it did not contain at firſt; the animal matter is reduced to coal, and fatty particles detach themſelves from it. If we analyze the ſulphuric acid, we find it in part

part ſaturated with ammonia and ſoda. We therefore find that it has decompoſed the animal ſubſtance, that it has ſeparated from it hidrogen and oxigen, which have united to form the water neceſſary for its ſaturation; that another portion has compoſed ammonia, a third has paſſed into the ſtate of fat, and a fourth into that of a coally reſiduum.

5. When we afterwards dilute the acid with a ſufficient quantity of water, then filtrate it in order to ſeparate the fat and coally matter, and analyze the filtrated liquor, we find in it ſulphate of ammonia, ſulphate of ſoda, ſulphate of lime, and a more or leſs conſiderable quantity of acetous acid, which may be obtained by diſtillation. It is therefore proved, that the ſulphuric acid has decompoſed the ſalts of ſoda and of lime contained in the animal matter, that it has converted it into ammonia, acetous acid, water, fatty matter, and coal. We here find an analogy with its effect upon the vegetable ſubſtances deſcribed in the preceding ſection; with very remarkable differences, the formation of ammonia and of fat, and the production of the ſulphate of ſoda and of lime. It would be ſuperfluous to explain in detail the cauſes of theſe differences, ſince what has hitherto been ſaid ſhows ſufficiently that they ariſe from the azote of the animal matters, the greater proportion of their hidrogen, and the preſence of the phoſphoric ſalts.

6. If

6. If inftead of leaving the fulphuric acid to act fpontaneoufly upon the animal matters, we affift its action by heat, its effect becomes more rapid and more effectual. It is no longer, as in the former cafe, merely the tendency of the acid to become faturated with water that effects the decompofition of thefe fubftances, and which brings into play the complicated attractions proper for changing their nature. The principles of the fulphuric acid themfelves tend to feparate; the attraction of the hidrogen and of the carbon of the animal matters for the oxigen of the acid, is augmented by the addition of caloric; a more profound alteration takes place in their nature and compofition. There is no longer any oily fubftance formed, with water fimply conftituted for the faturation of the acid which no longer retains its character; the animal matter approaches much more to the ultimate term of its decompofition. Accordingly we fee an effervefcence arife, which is prolonged; carbonic acid gas, fulphureous acid gas, fulphurated and carbonated hidrogen gas difengaged. Much water paffes in diftillation; for this experiment ought to be made in a diftilling apparatus; the acetous acid is deftroyed; we obtain fulphate of ammonia, and the quantity of coally refiduum is lefs than in the firft cafe.

7. The nitric acid comports itfelf in a very different manner with the animal matters, becaufe it is much lefs powerful and permanent, as

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an acid, than the fulphuric, and efpecially becaufe it is infinitely more decompofable and much more oxigenated. It was formerly remarked that it gives to thofe fubftances a lemon-yellow colour, and that it does not reduce them to coal like the preceding. Its mode of acting upon the vegetables, which has been explained in detail, in one of the articles of the fection relative to them, will here ferve me to account for that which it exerts upon the animal matters; we fhall obferve a more complicated operation; we fhall remark in it important refults which the pneumatic doctrine has enabled us to deduce from it. When Bergman made known the formation of the acid of fugar, or the oxalic, by the nitric acid, Citizen Berthollet found, in 1777, that filk, wool, the mufcles, the fkin, the tendons, and the hair, afforded more of it than fugar, and that this quantity fometimes even amounted to more than half of their weight, whereas fcarcely a fourth could be obtained from the vegetable matters. He difcovered at the fame time, and, as we fee, at a period already remote (now nearly twenty-two years ago), that there was feparated an oil, during the formation of the oxalic acid, from the animal matters, and that this oil yielded ammonia in diftillation. This was already a ftriking difference obferved in the action of the nitric acid upon thefe matters.

8. Eight years after this firft difcovery, the fame chemift made another ftill much more important

portant difcovery, relative to the action of the nitric acid upon the animal matters. Having feen that they yielded by this acid, when rather weak, and almoft without the addition of heat, a large quantity of azotic gas, he remarked that this property accorded with that of yielding ammonia; that when they had loft their azote they feemed to make a retrograde ftep toward the vegetable ftate; that all the fubftances which furnifh ammonia exhale alfo azotic gas by the action of the nitric acid; that in this action there was difengaged, after this gas, carbonic gas and nitrous gas; that the oxalic acid was then formed, and the fatty matter feparated; that when the yellow liquor was evaporated in order to obtain the oxalic acid, acid phofphate of lime remained in the mother water: thus he eftablifhed a very effential difference between the vegetable and the animal matters. I examined, a fhort time after this difcovery, all the circumftances of the difengagement of azote from animal matters by the nitric acid; I have proved that this acid was not decompofed as long as that difengagement continued, and that it thus belonged to the animal matter; that gelatinous matters afforded lefs of it than the albuminous, and thefe lefs than the fibrous; that the azotic gas thus obtained, had a particular faint odour, analogous to that of animal matters when they begin to become tainted, to that of muriate of ammonia fublimed, of ammonia decompofed by the oxigenated

muriatic

muriatic acid, &c.; and that its proportion exactly followed that of the ammonia afforded by each animal matter; that when it had been feparated from an animal compound, this was no longer putrefcible as before; that this gas was very deleterious, that it appeared to have an influence upon the production of putrid difeafes in men expofed to its action. Since my firft affertion, fome have attempted to make a point of medical theory of this object, and its refult has been defignated by the name of *fepton gas*, given to the azotic gas.

9. In 1790, another difcovery prefented itfelf to me in the courfe of my experiments relative to the action of the nitric acid upon the animal fubftances; namely, the formation of the Pruffic acid, and its difengagement in vapour, eafily diftinguifhable by its ftrong fmell of bitter almonds: as it will be treated of more in detail in one of the fubfequent articles, I fpeak of it here, only in order to complete the enumeration of the principal effects of this acid. We fee that thofe effects confift in a yellow or red colouration, in the difengagement of azote in the ftate of gas, in the formation of the Pruffic acid, of the oxalic acid, of the carbonic acid, and of a fatty matter. The difference of this action from that of the fulphuric acid, confift in the feparation of azote, the formation of a thicker oil, of lefs water, the abfence of ammonia, the non-precipitation of carbon, the formation of the oxalic acid; it

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depends evidently upon the greater ſolubility of the animal matter in this acid, its larger quantity of oxigen, which ſeizing the principles of this matter, inſulates and burns its carbon, employs its hidrogen with a portion of this carbon itſelf and of the oxigen in the formation of the kind of fat, &c. Theſe united effects are ſtill more numerous and more difficult to be well explained than thoſe produced by the ſulphuric acid, as there are more attractions acting at the ſame time; they are nevertheleſs very well adapted for making us acquainted with the nature of the animal ſubſtances and confirming what has already been enunciated reſpecting them.

10. The muriatic acid preſents nothing particular in its action upon the animal ſubſtances, neither do the phoſphoric or the vegetable acids; it is only a little more powerful than the latter. They all diſſolve the fibrous and muſcular part, reduce it into a kind of jelly; and at laſt they decompoſe and convert a part into ammonia, which ſaturates them. They coagulate the albuminous liquids, ſoften, and in part decompoſe the bones, as well as the cartilages; they alſo diſſolve the membraneous textures. It is believed that this effect takes place during life, by the abuſe of the vegetable acids, of the acetous and of the nitric acid, and that it is on this account that perſons who take them in abundance grow lean, and loſe even a portion of the bulk or of the thickneſs of

their

their mufcles. With refpect to the oxigenated muriatic acid, it acts with a far fuperior energy upon thefe fubftances. At the moment of its contact with thofe animal liquids, it thickens, coagulates and condenfes them into flakes, into mucous fragments, and thus confirms what I have faid of the coagulation of this humour by the combination or the fixation of oxigen. It hardens the folids, makes them fhrink and contract, weakens their colour without deftroying it, and even brightens that of feveral of them. We fhall fee hereafter that its powerful action upon the humours and the organs of living animals, is calculated to throw fome light, at a future period, upon their functions and phyfiology.

Article VI.

Of the Properties of Animal Matters derived from their Alterability by the Alkalis.

1. THE violent action of the cauftic alkalis upon animal fubftances has long fince been obferved by chemifts; but not knowing then either the pure ftate of the alkalis, or the intimate nature of the organic compounds, they were neither able to explain this action, nor to avail themfelves of it for the purpofe of afcertaining the compofition of thefe matters. It was a fact which they had obferved, without being

being able to deduce from it inferences ufeful for the advancement of the fcience, and they contented themfelves with making fome applications of advantage to feveral of the proceffes of the arts, fuch as the employment of fixed alkalis rendered cauftic by means of lime, for the purpofe of opening iffues, extirpating indolent and fteatomatous tumours, clearing the fat out of wool, &c. It is only fince the rife of the pneumatic doctrine that the action of the alkaline cauftics upon animal matters has begun to be known and employed for the purpofe of determining their nature.

2. It was firft remarked that thefe re-agents acted in a much more powerful manner upon animal than upon the vegetable fubftances, and that whilft they diffolved the latter but flowly and with difficulty, they foftened and diffolved the former with rapidity: it was alfo perceived that all animal textures treated by cauftic alkaline leys loft their ftrength and their weight, whilft thofe of vegetable filaments were but very little altered by them. To this action is to be attributed the kind of greafy and unctuous feel which we perceive when we rub the cauftic leys between the fingers; a phenomenon which caufed the name of *oil of tartar* to be given to the concentrated folution of pot-afh. This folubility of the animal matters takes place even by the folid fixed alkalis, becaufe they find a fufficiency of water in thefe matters

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to become firſt ſoftened and diſſolved, whence they are afterwards enabled to act as ſolvents.

3. In 1782, Citizen Berthollet publiſhed a Memoir upon this action of the alkalis: he repreſented it as the effect of a ſimple combination, into which the animal matters entered intire: he remarked that wool, ſilk, fleſh, boiled with a concentrated ley of pot-aſh, were diſſolved in it, deprived it of its cauſticity, gave it a bitter taſte, and a red colour, but did not take carbonic acid from it, as Macbride had believed; that this ſolution was precipitated by the acids and the metallic ſalts; that in the latter precipitation, the depoſit, compoſed of animal matter and oxide approaching to the metallic ſtate, was unalterable and not imprutreſcible; that it did not precipitate the ſuper-oxigenated muriate of mercury, whilſt a ſolution of ſugar and of ſtarch in the ſame alkali did not deſtroy its cauſticity but decompoſed this metallic ſalt; that the animal matter thus ſaturated the alkali.

4. A phenomenon obſerved by the ſame chemiſt induced me to adopt an opinion different from his; it led me to make a ſeries of experiments which furniſhed me with another theory, by ſhowing me that ſomething different from a ſimple ſolution took place. Citizen Berthollet had remarked that the ſolution of an animal matter by cauſtic alkali exhaled a diſagreeable putrid ſmell. I ſoon found that in fact every ſubſtance of this nature diſengaged a remarkable quantity of ammonia at the moment when it

was

was treated by a ſtrong alkaline ley; that at the ſame time caloric was diſengaged; that the ſame circumſtances took place, though with leſs energy, with lime, ſtrontian, and barites. As a freſh animal matter does not contain ammonia ready formed, I concluded that it was formed from it by the action of the alkalis, that after this the matter being once diſſolved was no longer the ſame as before its ſolution, but that its nature was changed. In the preparation of the animal ſoap which is manufactured according to the recommendation and the advice of Citizen Chaptal, by boiling ſhreds of woollen ſtuffs in a ſtrong ley of pot-aſh, till it diſſolves no more of them, this liquid and coloured ſoap, uſeful in the manufactories of flannels, of cloths, and of blankets, retains and gives to the ſtuffs a diſagreeable ſmell which proceeds from this ammonia that is formed, and is diſſipated in the air by much waſhing.

5. It is eaſy to conceive that in proportion as ammonia is formed, the animal matter loſing five times as much azote as hidrogen, muſt contain in its portion united with the alkali much more hidrogen than before, and that having thus contracted an oily character its alkaline combination is a real ſoap; accordingly, all the properties deſcribed by Citizen Berthollet in this ſolution are ſo many characters of a ſaponaceous compound. The acids decompoſe it and ſeparate from it a concrete brown oil;

oil; the metallic folutions form in it infoluble precipitates of foaps; and the fame is the cafe with the earthy falts. Citizen Chaptal has propofed it to anfwer the purpofes of a real foap in the woollen manufactures. It is evident that there is no proof wanting to my opinion.

6. The red or brown, more or lefs deep colour which animal fubftances affume when they are diffolved in the cauftic ley of fixed alkalis, indicates alfo another change of thefe fubftances. It is eafily conceived that when azote and hidrogen is feparated from them to form the ammonia which is difengaged, a portion of infulated carbon muft be precipitated, and that the oil then formed muft approach to the nature of thofe which are called empyreumatic. Petit obferved, in 1733, in the Memoirs of the Academy of Sciences, that a piece of lapis caufticus furrounded with fat and fkin, rendered thefe parts reddifh by remaining in them for fome hours. Poulletier de la Salle has defcribed, in his Commentary upon the Pharmacopeia of London, experiments made upon the application of the lapis caufticus to the fkin of a dead body, in which he obtained the fame refult. This agent, employed with the fame care and the fame apparatus upon the living fubject, produced an efchar, an excavation, with a margin of a livid-red colour, owing to its colouring action upon the fubcutaneous fat.

7. This action of the alkalis, which at prefent is well afcertained, explains their ufe as

caustics for removing malignant ulcers, indolent humors; it is evident how their employment as solvents for the diseases which require this kind of remedies, may become dangerous if abused; how the alkaline leys alter and weaken all the animal textures which are impregnated with them, or left to remain in them, and especially if heated with these liquors; as is frequently practised with wool, silk, hair, feathers, &c.

Article VII.

Of the Action of the Saline Substances, the Oxides and the Metallic Salts upon Animal Substances, considered as Character of these Substances.

1. I COMBINE in a single article the action of three kinds of substances upon animal matters, because it is either weak or difficult to be determined, or not yet appreciated with accuracy. There are few facts to be described, and few results to be deduced from the action of these bodies: it was, therefore, necessary that I should consider them together, not to separate them, but associate them in one consideration.

2. The preservative property which the salts show with respect to all the organic substances in general is well known, and a number of arts and

and proceffes efpecially prove the exiftence of this property with refpect to the animal matters. Alum hardens fkins and contracts their texture, which it renders more durable; its folution is frequently employed in order to preferve, againft every kind of alteration, the organs or the parts of animals in anatomical collections. The muriate of foda produces a fimilar effect, which preferves meat fo well, that it is employed in order to prevent its fpoiling and to adapt it for nourifhment. The fame procefs is employed for butter and cheefe. Pringle imagined that a fmall dofe of falt accelerated their putrefaction, whilft a large one was antifeptic: this opinion has been found to be an error, and that a fmall quantity of falt fuffers the animal matters to putrefy, only becaufe it does not abforb the whole of their humidity.

3. The earthy falts, whilft they prefent the property of the preceding, exhibit another character in their active energy upon animal matters; they decompofe their foluble phofphates, namely, thofe of foda and ammonia, which are almoft conftantly contained in the liquors of animals: hence it comes that when we pour folutions of nitrates and muriates of lime, magnefia, or ftrontian, into the ferum, whey, urine, the water of hydropic cafes, or water in which flefh has been boiled, &c. a more or lefs abundant precipitate is produced, which is always phofphate of lime. The foda which exifts infulated, or in the faponaceous ftate in feveral of

these liquors and in the bile, alfo decompofes thefe falts and precipitates their earthy bafes; fo that this precipitate is frequently two-fold and confifts of earthy phofphates and earth. In the cafe of the faponaceous animal liquors, the precipitate which is formed is an infoluble earthy foap. The aluminous falts, whilft they produce the fame effect upon the coloured liquors, frequently deprive them of their colour, with the matter of which alumine has a ftrong affinity.

4. It is evident from this expofition that the faline matters have almoft always a very complicated effect upon the liquid animal fubftances, a part of the falts of which they decompofe, becoming decompofed themfelves, efpecially when they are of an earthy nature, and that they preferve thefe matters when folid, and condenfe their texture. We muft, therefore, confine ourfelves to thefe effects the generality which it is here neceffary to prefent; we fhall hereafter have occafion to give an account of fome other actions exerted by the falts upon feveral animal fubftances in particular, to fhow that thefe actions depend upon the fpecial nature of thefe fubftances, and that they ought to be confidered as very proper for characterifing them. It can fcarcely be doubted that many falts with an alkaline bafe, which are not found in the animal compounds, produce in thefe compounds phenomena of decompofition, or of triple and perhaps quadruple union, which have not yet been deter-

determined. Much ſtill remains to be done for the Science in all theſe reſpects.

5. Thoſe metals which are the moſt eaſily oxided undergo this kind of alteration, when they are kept immerſed in ſeveral animal liquids. Iron, zinc, lead, and copper belong eſpecially to this order; their oxidation is more particularly ſpeedy and more marked in the albuminous liquors. This ſlow combuſtion is frequently ſucceeded by a real phoſphatization, by the union of the metallic oxides with the phoſphoric acid of the animal matters. Every one knows how eaſily ſilver becomes coloured and blackened by the contact of theſe matters, and even of the vapours which exhale from them. The ſulphurated hidrogen gas with which they are frequently charged is the ſource of this alteration; the ſulphur which abandons it, unites in the courſe of time with this metal, and it was the cauſe of the ſulphuret of ſilver formed by plates of this metal, which had remained for a long time in a privy at Compeigne, and were examined in 1765 by Macquer. Even the metals that are the leaſt eaſy to be oxidated, neverthelefs aſſume this ſtate by trituration with thoſe animal liquors which quickly abſorb this principle. It is in this manner that mercury, gold and ſilver, triturated with ſaliva and fat, are converted in a longer or ſhorter time into real oxides when they have the contact of the air.

6. The

6. The highly oxided metallic oxides, on the contrary, yield a more or lefs confiderable portion of their oxigen to the animal matters with which they are placed in contact. It is in this manner that thofe of mercury and of filver thicken and coagulate the albumen: fome of thofe which adhere the leaft with it, and fuffer it to be taken from them with more or lefs facility, even burn the animal compounds. Acknowledged as cauftics, when they are applied to thefe compounds in the living ftate, they may ferve for making their analyfis when they are deprived of life. The animal matters are reduced into coal by the action of thefe oxides; whilft it takes place water is formed, fometimes ammonia, and in other circumftances, nitric acid. It is on this account that the red oxide of iron, mixed with the animal fubftances employed in the artificial nitre-beds, contributes to the formationof this acid.

7. The folutions of the metals in the acids, act by both their component parts upon the animal liquors; there is not one of them that is not decompofed, and the oxide of which is not feparated and approached to the metallic ftate, by remaining in this liquor. Thofe of the white metals, and efpecially of mercury, and lead, and of filver, are precipitated at the very moment of their mixture with thefe liquors. This precipitate is formed either by the muriatic acid, or by the phofphoric acid, which form part of the elements of thefe matters; the

foda

ſoda which they contain, alſo contributes to it; the albumen, which frequently conſtitutes a portion of them, by taking oxigen from the oxides of the ſolutions alſo produces their ſeparation from the acid: ſometimes even the ſulphurated hidrogen diſſolved in the animal liquids, enters for ſomething into the precipitation; ſo that the precipitates obtained in theſe operations may be compoſed of five different matters; namely, of a phoſphate, a muriate, a ſimple metallic oxide, and the ſame oxide albuminated and ſulphurated: a delicate analyſis made ſlowly by means of different acids, may exhibit each of theſe metallic precipitates, and even give the proportions.

8. The action of the metals and of the metallic oxides and ſolutions upon the animal ſolids, has not yet been examined with ſufficient accuracy for it to be poſſible to deſcribe it with exactneſs. It is known that theſe ſolids are preſerved by theſe ſolutions; that they become coloured, condenſed, contracted, and hardened; that they abſorb a portion of the metallic ſalt; that they decompoſe another and ſeparate from it the oxide which they approach to the metallic ſtate; that they at the ſame time ſuffer an alteration more or leſs conſiderable, according to the differently concentrated ſtate of the ſolution, and that in the frequently dark colour which they acquire, their carbon is inſulated, and their hidrogen burned. The moſt acrid and moſt cauſtic ſolutions burn and entirely deſtroy the texture of the animal

ſolids,

folids, by reducing them to a complete coally ftate: it is for this purpofe that they are employed in furgery.

Article VIII.

Of the Action of Vegetable Matters upon the Animal Subftances, confidered as Generic Characters of the latter.

1. THE entire vegetables, or the different immediate materials of vegetables, have not nearly fo powerful an action upon the animal fubftances as that which they exert upon moft of the preceeding fubftances; the effect which they produce upon them is frequently almoft infenfible. It is not obferved, that they tend to diforganize them, to decompofe them, or to deftroy the equilibrium which exifts between their conftituent principles; we confequently find that they cannot be ufed for analyzing them. This action, however, is not a nullity; though it is feeble, it does not the lefs merit to be examined with attention, and defcribed with care: we find in it phenomena which may add to the chemical characters of the animal fubftances, and contribute to the underftanding of their nature.

2. Formerly we judged by the tafte of plants of their medicinal virtues, which fome phyficians had attributed to their chemical properties; but the erroneous notions which they had formed of the analogies of thefe two kinds of properties

perties are now baniſhed by a ſound theory; and they no longer form a part of the ſcience. It was thought that the juices of the vegetables mixed with the animal liquors ought alſo to ſhow, in their ſenſible action upon theſe liquids, the nature of their action in diſeaſes; ſome were ſolvent or attenuant, others inſpiſſant and incraſſant, ſome anti-putreſcent, others aſtringent and condenſing, others again ſeptic. It has been aſcertained that theſe experiments were not only mere chimeras as to the theraputic theory, but alſo real errors with reſpect to the chemical effects, which are ſtill too much complicated, even at the preſent day, when the ſcience is ſo much farther advanced, to be capable of being well determined.

3. We may with greater facility appreciate the immediate, though feeble effects, produced by the immediate materials of plants, when ſufficiently pure and inſulated, upon the animal matters. The mucilages diſſolve in their liquids, and frequently precipitate from them ſuch materials as are leſs ſoluble than thoſe which they contain. Sugar, whilſt it produces this firſt effect, acts beſides as a preſerver: ſometimes by its ſolution it favours the alterability and fermentability of which they are ſuſceptible. It has already been ſeen that the vegetable acids coagulate the albumen, diſſolve the fibrin and the gelatin, and prevent or retard their alterations.

4. All the inflammable oily bodies, all the materials of vegetables in which hidrogen appears

pears to be the ſuperabundant principle, act in an uniform manner upon the animal ſubſtances. When covered with fixed oil, they keep, and frequently ſuffer themſelves to be penetrated by it, like the ſkins which thus acquire pliability; the animal mucilages, the albumen, and the gelatin, render it miſcible with water by agitation, and ſuſpend it in emulſion; oil diſſolves the fats with the aid of heat.

The volatile oils, the balſams, the reſins, camphor, preſerve the animal ſubſtances from putrefaction: on this account they were employed by the nations of antiquity for the purpoſe of preſerving dead bodies in embalming.

So ſtrong and ſo marked an attraction is obſerved between the vegetable colouring matters and the animal textures; and this is ſo well demonſtrated by the ſolidity of the dyes applied to wool, ſilk, &c., that in order to make vegetable threads approach to the ſame ſolidity, they are ſucceſsfully impregnated with fat or animal oil, which diſpoſes the colouring matter to adhere to them.

The ligneous matter itſelf, however inert it may appear, is not entirely void of action upon the animal matters: when reduced into powder and thrown upon their ſurface, it dries it, abſorbs their moiſture, hardens them and preſerves them from alteration.

5. The different vegetable materials hitherto indicated are almoſt inert in compariſon with three other vegetable ſubſtances, the energy of which

which upon the animal compounds is infinitely ſtronger: theſe are the tannin, the gallin, and alcohol; each of them deſerves to be examined ſeparately. I have already upon a former occaſion ſpoken of the nature and general property of tannin; and I muſt hereafter treat with ſome detail of the cutaneous texture; it will, therefore, be uſeful here only to ſtate the general impreſſion which the animal matters experience from this ſubſtance. Tannin diſſolved in water precipitates the albumen and gelatin from their natural ſolutions or from the animal liquids which contain them. The precipitate, eſpecially that of the gelatin or glue, is ſoft, fawn coloured, ductile; it hardens and becomes brittle by drying: it is then inſoluble and unalterable This precipitation is ſo well adapted for characterizing the animal ſubſtances and eſpecially the gelatin, that by its quantity we may determine that of this principle as well as aſcertain its preſence. It is alſo found that tannin, which has become an uſeful re-agent in the animal analyſis, is the moſt powerful of the vegetable antiſeptics, ſince tanned ſkins experience no more ſenſible alteration and keep a long time without change. This property will, at ſome future period, afford an uſeful application to medicine; it may already be employed with advantage for anatomical preparations and for preſerving membranous organs.

6. *Gallin*

6. *Gallin* I term the impure gallic acid, combined with a ſmall portion of extractive, or of a vegetable principle hitherto unknown, in which its aſtringent taſte principally reſides. It exiſts almoſt always along with the tannin; it is not abſorbed by the animal matters, nor precipitated by the ſolution of glue: ſo that water ſaturated with tan, and afterwards deprived of tannin by the ſkins which have taken it from it, contains this gallin which is exhibited in it by precipitating the ſulphate of iron. Mr. Prouſt has ſeparated the gallin from the tannin, both contained together in a decoction of gall-nuts, by uniting it with muriate of tin which ſeizes the tannin by which the oxide of tin is precipitated, and leaves in the ſupernatant liquor the gallin with the muriatic acid. Citizen Seguin has diſcovered in the gallin the property of diſoxigenating or unburning animal matters, and of diſtending them, by ſwelling them in ſuch a manner as to diſpoſe them by this double effect to combine with the tannin. The uſe of the gallin as a re-agent may hereafter be carried ſo far as to enable us by its means to aſcertain the ſtate of oxigenation of the different animal ſubſtances.

7. Alcohol, the product of a ſpontaneous alteration of the ſaccharine matter that has been elſewhere deſcribed, has itſelf a very marked action upon the animal compounds; its effect is fourfold upon theſe compounds according to their different nature: it diſſolves ſome and

and may ſerve to ſeparate them; it coagulates others; ſome it preſerves and even hardens their texture.

It effects the ſolution of the animal reſins, of ſome colouring parts of animals, of ſeveral of their acids, of certain fats, eſpecially of that which I call *adipocire*, and which is found in the dried liver, in biliary calculi, &c.

It coagulates the albuminous liquids; it precipitates from them the albumen in ſmall flakes almoſt pulverulent which may be diſſolved in water, as Bucquet has remarked, at the moment when they have juſt been precipitated.

It preſerves and defends againſt putrefaction almoſt all the animal matters liquid or ſolid: it is employed for this purpoſe in anatomical laboratories, and even in medicine.

Finally, it hardens the texture, contracts and condenſes the fibres of moſt of the ſolids of animals; it condenſes and hardens their plates and laminæ.

ARTICLE IX.

Of the Property of Forming Pruſſic Acid and ſome other Acids, conſidered as Character of the Animal Compounds.

1. THOUGH the diſcovery of Pruſſian blue, made in the firſt years of the eighteenth century by Dieſbach and Dippel, two chemiſts of Berlin, had at firſt only a colouring matter uſeful in painting for its object, it might ſince that time be thought that it would have a direct influence upon animal chemiſtry, as it really belongs to the ſubſtances of this nature, and was made by a chemiſt who had much occupied himſelf with theſe ſubſtances. However its relations with this kind of analyſis, and the characters which I now derive from it in order to diſtinguiſh the animal ſubſtances, were not very perceptible till after the experiments of Citizen Berthollet in 1787, and eſpecially till after a diſcovery made by myſelf, in 1790, upon the production of the Pruſſic acid, during the treatment of animal matters by the nitric acid. It required the labours of nearly eighty years to aſcertain this influence; and this is the reaſon why I think it incumbent upon me to give a ſomewhat detailed hiſtory of theſe labours

labours, or at leaſt of the principal epochas which conſtitute it.

2. It was a little before the year 1710, that Dieſbach, having borrowed from Dippel ſome alkali, in order to precipitate a lake, or extract from ſulphate of iron, accidentally obtained a very beautiful blue. The latter chemiſt, knowing that this alkali had repeatedly ſerved him for diſtilling and rectifying animal oils, eaſily reproduced this colour by precipitating ſulphate of iron with a ſimilar alkali. This diſcovery was announced in the Memoirs of the Academy of Berlin, in 1710. In 1724, Woodward deſcribed, in the Philoſophical Tranſactions, the firſt proceſs for preparing this new blue, which made much noiſe. It conſiſted in calcining in a crucible equal parts of ox-blood and pot-aſh to redneſs, lixiviating the product with boiling water, mixing this lixivium with a ſolution of ſulphate of iron and of alum, and employing muriatic acid in order to brighten the blue, which was waſhed with a large quantity of water. This very good proceſs is ſtill in a great meaſure followed in the workſhops The name of *lixivium of blood* was given to the liquor obtained from the alkali treated with this ſubſtance, afterwards diſſolved in water, and thus diſpoſed to precipitate the iron in the blue ſtate.

3. The chemiſts zealouſly laboured upon this proceſs, and at firſt ſought various means for rendering the alkali capable of producing this colour,

colour. Brown, in 1724, found that the alkali treated with flesh acquired this property in the same manner as with blood; and he endeavoured to explain its formation by means of a bituminous principle of iron, developed by the blood, and fixed upon the alumine. Geoffroy, the physician, discovered in 1725, that oil, wool, hartshorn, sponge, and even thyme calcined with alkali, give it the same action upon the sulphate of iron; he thence explained the blue before described in soda treated with the acids by Henckel: and he adopted the theory of Brown. Neuman endeavoured to treat the alkali with many different oils, and succeeded in communicating to it the tinging property by these inflammable bodies. Menon gave, in the Memoirs des Savans étrangers of the Academy of Sciences of Paris, a new theory of Prussian blue: he pretended that blue was the natural colour of iron, and that blood insulated it by purifying or refining this metal. Thus forty years passed without any other notion being added to the first discovery, except the possibility of obtaining blue with various matters different from blood, especially animal substances.

4. In 1752, Macquer, in an excellent Memoir, inserted amongst those of the Academy of Sciences, advanced the theory of this preparation a considerable step farther, by discovering the discolouration of Prussian blue by the alkalis. He showed that the alkaline leys became saturated with

this colouring matter, by caufing them to pafs over Pruffian blue till they ceafed to difcolour it, and again formed an abundant quantity of pure blue, when they were poured into a folution of fulphate of iron; that thefe faturated leys were in a ftate different from that of the immediate ley of blood, as this did not directly precipitate the iron into the blue, but in the grey or green ftate, on account of the portion of alkali not faturated. He fufpected that the colouring matter faturated the alkalis after the manner of an acid; that it adhered to them much in the fame manner as to iron, fince the fimple acids, according to him, did not difengage it from them; that in order to take it from them and transfer it to the iron, it was neceffary to employ a double affinity. He fubftituted, inftead of the vague theory of Brown and Menon, that of the alkali faturated by *phlogifton*; this was transferred again to the iron, which it furcharged by feparating it from the acids.

5. More than twenty years elapfed after the ingenious labours of Macquer, without any thing being added to his doctrine, which was adopted by almoft all the chemifts, who were then fatisfied with it. They contented themfelves with profecuting their refearches concerning the bodies capable of *phlogifticating*, as they expreffed it, the alkali; Weifman found this property in the empyreumatic oils; Model, in foot; Cartheufer in feveral vegetable afhes; Jacobi,

Jacobi, in the coal of the vine; Spielman, in the bitumens, and Goettling, in the fungufes. Till 1775, no change or modification of the theory of Macquer was propofed.

6. At this laft epocha, Bergman, in his Differtation upon the Elective Attractions, began to throw fome new light upon this fubject, by reprefenting the colouring matter of the Pruffian blue as a diftinct acid, having its particular attractions. Several chemifts, amongft others Delius and Scopoli, beftowed much more attention upon the products of the Pruffian blue by fire; they remarked that it afforded much ammonia. Citizens Deyeux and Parmentier obferved, that when treated with lime and the fixed alkalis, a confiderable quantity of this volatile alkali was difengaged from it. It was then fufpected that it contained its materials like the animal fubftances, and this idea undoubtedly guided the chemifts who afterwards undertook refearches upon this fubject. Mr. Fontana found that the fulphuric acid, diftilled upon Pruffian blue, paffed into the fulphureous ftate, and that this coloured fubftance detonated with nitre. Mr. Landriani difcovered that it yielded, in its diftillation, befides ammonia, a mixture of azotic gas and of hidrogen gas, burning with a blue flame, and not detonating with oxigen gas.

7. Thefe were in fome meafure preludes to the important difcoveries of Scheele, who fuddenly raifed himfelf above all thofe who had

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occupied themſelves with this ſubſtance. This celebrated chemiſt undertook to aſcertain, both the compounds of which the Pruſſic acid forms a part, the properties of this acid, which before him no one had been able to inſulate, and its intimate nature, by decompoſing it, and alſo by forming it in a direct way with materials leſs complicated than the animal ſubſtances. His diſcoveries upon theſe different points are contained in two Memoirs inſerted in the Trimeſtres of the Academy of Stockholm, of December 1782, and January 1783. He began with examining the ley of blood: he ſaw that it was altered by the contact of gaſeous carbonic acid; that this acid diſengaged from it a vapour, which converted ſulphate of iron placed upon a ſtopper at the top of the apparatus into blue; that the ſulphuric acid alſo ſeparated it from it with the aid of diſtillation; that the Pruſſian blue, diſtilled with this acid, yielded an elaſtic fluid, which tinged the oxide of iron blue; that, when diſtilled alone, the Pruſſian blue yielded a portion of this colouring vapour, and ammonia ſaturated with it; that the ley of blood diſſolved a ſmall quantity of oxide of iron, which rendered it more ſolid and more permanent; that the iron eminently poſſeſſed the property of fixing the Pruſſic acid; that fire and the acids were nevertheleſs capable of volatilizing this colouring matter; that an alkaline ley, whilſt it diſcoloured the Pruſſian blue, diſſolved a ſmall portion of it entirely, and thus acquired a more durable

 character.

character than the ley of blood; that an acid diſtilled with the pruſſiate proceeding from the diſcolouration of the Pruſſian blue, precipitated from it an abundant quantity of real Pruſſian blue, becauſe it was decompoſeable only in its portion of alkaline Pruſſiate, and not in its ferruginous Pruſſiate.

8. After having diſcovered the poſſibility of obtaining the colouring matter of Pruſſian blue ſeparate, and being able to obſerve its properties in its pure ſtate, he ſought the moſt ſpeedy and moſt certain means of effecting this ſeparation, which till then had been unknown to the chemiſts, who had not yet had this matter otherwiſe than combined with the alkalis and the metals: Scheele preferred the following proceſs, which has been practiſed ſince his time. Two parts of Pruſſian blue, and one part of red oxide of mercury, are boiled in ſix parts of water till the whole is decolourated: to the lixivium is added half a part of iron-filings, and a little leſs of ſulphuric acid; the mixture is diſtilled, and nearly a fourth of the liquor is drawn off, which is rectified by diſtilling it again upon chalk, in order to abſorb the portion of ſulphuric acid which it may contain. In this operation, the oxide of mercury takes away the Pruſſic acid from the oxide of iron, and is diſſolved in Pruſſiate of mercury, white, cryſtallizable, &c. The iron, which is added in the metallic ſtate, reduces the oxide of mercury, and at the moment when it unites with the ſulphuric acid, added at the ſame time, the

the heat which is employed volatilizes the Pruſſic acid ſeparated from the mercury, which has been reduced to the metallic ſtate. The Pruſſic acid thus obtained, partly in liquor and partly in gas, produces, when united with the alkalis, the ſame effects as the leys of blood and of decolourated Pruſſian blue. We ſhall ſoon return to its diſtinctive characters.

9. Scheele was not content with having found the means of inſulating and obtaining pure the colouring matter of Pruſſian blue or the Pruſſic acid; he wiſhed alſo to aſcertain what it was compoſed of, and conſequently to know how it is formed in animal matters. In order to determine its conſtituent principles, he firſt obſerved, that in the proceſs of abſtraction the air of the receiver was inflammable; that in decompoſing the Pruſſiates by fire, he obtained ammonia and carbonic acid; that ſome metals were afterwards found reduced by the diſtillation of theſe metallic Pruſſiates. He then ſuſpected that this acid was compoſed of ammonia and oil, and directed his ſubſequent reſearches upon this ſuppoſition; but he could not ſucceed in forming the colouring compound with ammonia and different oils or fats heated together. Obſerving that the water was an obſtacle to this formation of Pruſſic acid, he conducted his experiments in a different manner, by uniting ammonia with the dry inflammable principle which he admitted in the oils, and with the carbonic acid alſo dry.

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He ſaw that the coal alone, heated ſtrongly with fixed alkalis, gave them the property of colouring iron blue. Having heated theſe two matters in crucibles, he added in one muriate of ammonia at the moment when the firſt mixture was heated to incandeſcence, and he continued to heat it till no vapour was diſengaged. This proceſs afforded him a ley which produced much Pruſſian blue, whilſt the operation in which he had contented himſelf with heating the alkali and the coal without addition of muriate of ammonia, afforded only an inappreciable quantity of it.

10. Scheele concluded from theſe laſt experiments, that the Pruſſic acid or the colouring matter of Pruſſian blue was a compound of ammonia and of a very ſubtile highly attenuated coal; that this compound, having become fixed by the ſtrong heat with which it was formed, united with the fixed alkali, which it rendered capable of precipitating Pruſſian blue, or that the alkaline Pruſſiate, the Pruſſian alkali, was only a compound of alkali, coal and ammonia,—that in the diſtillation of the Pruſſian blue, the fire abſorbed the inflammable principle and ſuffered the carbonic acid and the ammonia to be diſengaged; that a ſmall quantity of Pruſſian acid was ſeparated undecompoſed; and laſtly, that the oxide of mangaueſe heated with it, rendered its decompoſition complete. The Pruſſic acid, extracted by his proceſs had, according to him, as its characters, a ſmell like that of the bloſſoms

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of the peach tree, a taſte ſweetiſh at firſt, afterwards acrid and burning, the property of not reddening the blue colours, but of precipitating ſoap and the alkaline ſulphurets, that of combining with the alkalis, and of forming ſalts capable of precipitating the metallic ſolutions, and eſpecially thoſe of iron in the blue ſtate. He diſtinguiſhes amongſt the ſaline compounds of this acid, the Pruſſiate of lime, which he recommends, as being very pure, to ſerve as a teſt proper for aſcertaining and indicating the preſence of iron with certainty in waters, &c.; a teſt which the chemiſts have ſought with much care for a great number of years paſt. Two years before the labours of Scheele, in 1780, I employed this calcareous Pruſſiate, in my courſes of Lectures, as a teſt for aſcertaining the preſence of iron.

11. Such was the ſtate of the Science with reſpect to the colouring matter of Pruſſian blue, or the Pruſſic acid, when Citizen Berthollet communicated, at the cloſe of the year 1787, to the Academy of Sciences, a new inquiry in which he employed with great ſagacity, and by the aid of the new data of the French pneumatic doctrine, the experiments of Scheele, adding to them ſeveral others, and converted the ſtill uncertain and inadmiſſible theory of the French chemiſts into an explanation that agreed much better with the views of the modern chemiſtry. The reſult of his inquiry was, as it were, the reſult of the light which he had thrown

thrown upon the nature of ammonia ſome years before. The compoſition of the one, once well known, muſt in fact have neceſſarily conducted him to the knowledge of the other, ſince even the reſearches of Scheele had already ſhowed a ſingular analogy between theſe two compounds, equally abundant amongſt the products of the animal matters.

12. The French chemiſt firſt proves that the alkaline Pruſſiate, formed by the diſcolouration of the Pruſſian blue, by means of alkali, contains iron; that its lixivium, being evaporated and afterwards re-diſſolved, yields octahedral cryſtals, the points of which are truncated near their baſes; that, mixed with ſulphuric acid and expoſed to the ſun, its ſolution depoſits Pruſſian blue, and is decompoſed; which does not happen to it in the ſame manner in the ſhade; that the Pruſſiate of mercury cryſtallizes in four-ſided priſms, terminated by pyramids with four faces correſponding with the edges of the priſms; that the muriatic acid diſengages more Pruſſic acid from it than the ſulphuric acid; that this acid, in decompoſing the Pruſſiate of mercury, forms a muriate in a ſingular ſtate.

13. After theſe preliminary experiments, he proceeds to the examination of the intimate nature of the Pruſſic acid by the action which the oxigenated muriatic acid exerts upon it. The latter, in proportion as it diſſolves in the Pruſſic acid, returns to the ſtate of ordinary muriatic

muriatic acid; the Pruſſic acid becomes more odorous, more volatile, leſs ſuſceptible of uniting with the alkalis, and precipitates iron in the green ſtate from its ſolutions. This green precipitate again becomes blue in the light by the contact of the ſulphureous acid, by iron: it is the oxigenated *Pruſſic* acid. By accumulating in it new oxigenated muriatic acid, which is made to paſs into it in gas, and by expoſing it to the light, water is ſeparated, to the bottom of which it is precipitated in the form of an aromatic oil, which heat reduces into an inſoluble vapour, that can no longer unite with iron. Thus ſuper-oxigenated, this acid can no more return to its firſt ſtate; it is far remote from its primitive nature.

14. The oxigenated Pruſſiate of iron, which is alſo prepared by treating the Pruſſian blue with the oxigenated muriatic acid, and is diſtinguiſhed by its green colour, loſes its acid which is ſuddenly converted into carbonate of ammonia by the contact of a fixed cauſtic alkali. The Pruſſic acid does not contain ammonia ready formed, as Scheele and Bergman thought; it contains only its elements, azote and hidrogen, both combined with carbon. When a ſufficient proportion of oxigen is added to this combination, the ſucceſſive addition of an alkali or of lime quickly deſtroys the Pruſſic compound by the pre-diſpoſing attraction which they have for the carbonic acid. Accordingly, Citizen Berthollet has been led by his experiments

ments to conſider the Pruſſic acid as a combination of three ſimple combuſtible bodies; hidrogen, carbon and azote, the proportions of which, however, he has not found, though he has announced that thoſe of the hidrogen and azote approach to the ammoniacal compoſition.

15. This reſult, which is much more preciſe than that of the Swediſh chemiſt, has furniſhed Citizen Berthollet with the means of eaſily explaining the principal phenomena which the Pruſſiates preſent, as well as the formation of the Pruſſic acid. The following are the facts which he has eſpecially conſidered under this new point of view:

A. The metallic Pruſſiates diſtilled, yield carbonated hidrogen gas and carbonate of ammonia, and their oxides are more or leſs reduced; for the oxigen of the oxides, ſeizing the carbon, leaves the azote and the hidrogen to unite with one another; the oxigenated muriatic acid acts in the ſame manner.

B. The animal matters form Pruſſic acid in proportion to the azote they contain, which combines with the hidrogen and carbon.

C. In the experiments of Scheele, the muriate of ammonia heated with fixed alkali and charcoal is decompoſed: it is by the elements of the ammonia and not by the entire ammonia that this ſalt contributes to the formation of the Pruſſic acid.

D. The hidrogen, which forms part of this compound, is the caufe of the violent inflammation produced efpecially by the fuper-oxigenated muriate of pot-afh.

16. Citizen Berthollet, not having found oxigen in his experiments of decompofition upon the Pruffic acid, thinks himfelf authorized to conclude from thence that this acid contains no acidifying principle. On this occafion he examines the fingular nature of this compound; though he difcovers in its properties very remarkable differences between it and the other acids, he thinks, however, that it approaches the neareft to the nature of thefe bodies, and that it ought to be ranked in their clafs. He efpecially infifts upon its analogy with ammonia, and the tendency which it has to pafs into the ftate of this volatile alkali. He terminates his inquiry by the explanation of a very fingular phenomenon of attraction which the Pruffic acid prefents, and which Scheele had confidered as an irrefoluble problem; namely, that it cannot be feparated from the metals by the other acids, and that, neverthelefs, it cannot by itfelf take away from thefe acids the metallic oxides that are diffolved in them. He explains the apparent contradiction in the doctrine of affinities, by the great quantity of fpecific caloric which this acid when pure contains, and by the ftrong tendency which it has to affume the gafeous form.

17. We

17. We fee from the ingenious refearches of Citizen Berthollet that the production of the Pruffic acid by the decompofed animal matters, whilft it exhibits one of the moft proper characters for diftinguifhing them and afcertaining their nature, prefents a property fingularly related with that of forming ammonia. But in what does this property of affording Pruffic acid or ammonia precifely refide? and what is the caufe which determines the production of the one rather than the other? In order to folve this queftion, which is of great importance to Animal Chemiftry, it is to be obferved, that the formation of ammonia fuppofes a more advanced decompofition than that of the Pruffic acid, as the one reprefents a binary compound, whereas we ftill find in the other a ternary compound, more approaching to the nature of the primitive animal matter by its very complication. In the fecond place, it is to be remarked that the production of the Pruffic acid is not fenfibly favoured, or does not take place in any abundance except when we treat the animal matters by a fixed alkali, efpecially aided by a metallic oxide; it is, therefore, the pre-difpofing attraction, exerted by two bodies at the fame time, which ought to be confidered as the caufe of this formation of Pruffic acid. Finally, it muft not be omitted, that the production of the Pruffic acid never takes place except in a very fmall quantity comparatively with that of the animal fubftances which afford it, that it amounts

amounts only to ſome thouſandths or at moſt to two or three hundredths; and that the carbonate of ammonia which they afford is in a quantity twice or thrice as conſiderable, on account of the carbonic acid which ſaturates it, and which is formed at the ſame time.

18. In 1790, three years after the inquiry of Citizen Berthollet, I pointed out a new fact, which I thought adapted to elucidate the nature and the formation of the Pruſſic acid. In treating the ſerum of coagulated blood by the nitric acid, I was ſtruck with the ſmell of Pruſſic acid. The vaporous product diſengaged in this experiment having been collected, I found it to be real pure Pruſſic acid; I even obtained a ſufficient quantity of it to induce me to believe that this very ſimple proceſs might be ſubſtituted inſtead of that of Scheele, which is much more complicated, in order to obtain this acid; azotic gas had been diſengaged with it and carbonic acid gas was formed. This led me to think that a ſimple change in the proportions of the conſtituent principles of the animal matters was ſufficient to give riſe to the Pruſſic acid; and that, as in the formation of the nitric acid, azotic gas had at firſt been diſengaged, there was reaſon to believe that this acid contained leſs azote than the ammonia, ſince in the formation of the latter this principle was not ſeparated before that formation had taken place. It cannot therefore be admitted, either that the Pruſſic acid is a ſolution of carbon in ammonia, as

Scheele had presumed, or that it contains azote and hidrogen in a proportion nearly approaching to that which forms ammonia, as Citizen Berthollet had announced. This opinion of the quantity of azote proportionably larger in the Prussic acid than in ammonia may even be supported by one of the facts which had been well observed by the latter chemist; I mean, the disengagement of a certain quantity of carbonated hidrogen gas during the formation of the carbonate of ammonia, which accompanies the decomposition of the Prussic acid by fire. Neither does it appear to me to be well proved that this acid ought to be considered as wanting oxigen, and as formed merely by the union of three simple combustibles, both because Citizen Berthollet who has proposed this opinion has not made an accurate analysis of this acid, and because the comparison which he has established between this acid, the muriatic acid, and the sulphurated hidrogen, is very far from being equivalent to a proof; and finally, because the constant production of the carbonic acid in all cases of the decomposition of the Prussic acid, even not previously super-oxigenated, the six-times more considerable quantity of Prussic acid obtained by Citizen Vauquelin, in decomposing muriate of ammonia mixed with charcoal by the oxide of lead, than that which he obtained in performing the same operation with lime instead of oxide of lead, militate strongly in favour

favour of the adoption of oxigen in this acidified compound.

19. The formation, the nature and the properties of the Pruſſic acid, as a characteriſtic production of the animal compounds, are ſo neceſſary to be accurately known in order that we may form a right conception of the properties of theſe compounds, that it appears indiſpenſable to me here to enumerate the ſeries of properties that belong to this important product, conſidering it as inſulated, and prepared either by the proceſs of Scheele, or by that which I have indicated (No. 18):

A. The Pruſſic acid has a ſtrong odour of peach-bloſſoms or of bitter almonds. This ſmell impregnates for ſome time the ſaliva of thoſe who reſpire it.

B. Its taſte, which at firſt is ſweetiſh, ſoon becomes acrid, hot and virulent; it excites coughing.

C. It has a great tendency to aſſume the gaſeous form, and frequently ſome of it is loſt in this form in the veſſels into which it is received.

D. It is decompoſed at a high temperature, and by the contact of light: it is thus changed into carbonic acid, ammonia, and carbonated hidrogen gas.

E. It combines with the alkaline baſes with difficulty, and without deſtroying their alkaline property.

F. Its

F. Its weakneſs, already proved by the preceding property, permits the carbonic acid to diſplace it from the alkaline Pruſſiates.

G. It takes oxigen from the oxigenated muriatic acid, and its nature is changed by the addition of this principle.

H. It does not act upon the metals; it unites with their oxides, the colour of which it changes, and with which it forms in general inſoluble ſalts.

I. It has a great propenſity to form triple ſalts with an alkaline and metallic baſe. Theſe triple Pruſſiates, theſe complex combinations are more permanent and more fixed than the ſimple alkaline Pruſſiates; they are no more decompoſed by the carbonic acid, light, the air and the acids.

K. When it is united with the metallic oxides, it cannot be ſeparated from them by the acids; as in theſe combinations it acquires a great fixity and a great adherency; and yet when it is inſulated, it cannot carry off the oxides of the metals from the other acids, on account of its ſpecific caloric, and its tendency to aſſume the ſtate of gas.

L. According to the reſearches of Citizen Berthollet and Mr. Prouſt, there are two ſpecies of metallic Pruſſiates, the ſimple and the ſuper-oxigenated: there is even reaſon to believe that with reſpect to iron there are three, the white, the blue and the green, the progreſſion being made from the moſt to the leaſt oxigenated.

M. The

M. The fuper-oxigenated Pruffic acid is very near to decompofition; the mere contact of a fixed alkali deftroys it and converts it into carbonate of ammonia, becaufe the oxigen being fufficiently abundant, and attracting the carbon, permits the azote to unite in particular with the hidrogen to form ammonia; the hidrogen exceeding the proportion of the latter compofition is difengaged in carbonated hidrogen gas.

20. The nature, the compofition, the decompofition of this acid being once well demonftrated, its relations with the animal matters which produce it are ftill better determined by the confideration of the different principal circumftances of its production. I find four of them which equally demonftrate a like feries of decompofition that takes place in thefe matters.

A. The action of fire; we have feen that it is obtained amongft the products of the bones, the blood, the urinary calculus; it is combined in them with ammonia.

B. The action of the nitric acid; when this acid is weak, it firft difengages azote from the animal matters; when it is ftrong and concentrated, it immediately volatilizes Pruffic acid from them, and at the fame time are formed carbonic acid, oxalic acid, and the adipocirous matter.

C. The action of the fixed alkalis; the animal fubftances, heated by a ftrong fire with the alkalis, faturate them in part with Pruffic acid after they have been reduced to coal.

 D. Finally

D. Finally putrefaction, by destroying the animal composition, sometimes gives rise to Prussic acid, which easily finding oxide of iron, combines with it and gives it a blue colour; hence proceed the native Prussian blues described by several naturalists.

21. What I have just set forth concerning the Prussic acid may be applied to some other particular acids of animals, though they be few in number; for we must not rank in this class the oxalic, acetous, sebacic acids, which being found the most frequently amongst the products of the vegetable matters, have the composition and all the chemical characters of such matters. When these acids are formed in the animal substances they really belong only to these matters in a retrogradation towards their first origin, or in some measure descending, by a commencement of decomposition, to the condition of vegetable substances. I know scarcely any other than the zoonic acid discovered by Citizen Berthollet, the uric acid constituting one of the species of the human urinary calculi, and one of the materials of arthritic concretions, the lactic acid, and perhaps the acids of insects, which appear to belong to this class of animal acids, when they do not present all the properties of acetous acid, like the former acid. The most marked character of these animal acids is that they can be converted into Prussic acid by chemical means; they also deserve to be examined anew under this point of view, especially the zoonic,

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the lactic, and the uric acids, which are very little known with respect to their intimate composition.

Article X.

Of Putrefaction, considered as Characteristic Property of the Animal Substances.

1. THE last and one of the most striking characters which distinguish the animal from the vegetable matters, consists in the kind of spontaneous decomposition which they experience, and which is called putrefaction. Though the vegetable substances are not exempted from this decomposition; though nature has subjected them to this law which equally embraces all the organic matters, the slightest observation is sufficient to show that putrefaction is infinitely more powerful and more rapid in the animal compounds, which are more disposed to it by their very composition, and that it establishes itself in them, develops itself and goes through its periods with much greater activity. It is not necessary to present it here as an intestine motion which tends to change the nature of the substances which experience it; for all that has already been said, both in the history of the vegetable substances, and in the preceding articles concerning the animal matters render this sufficiently evident.

2. It

2. It is already a long time fince philofophers and naturalifts have acknowledged all the intereft which the ftudy of putrefaction prefents for the fciences, and efpecially for the art of healing. Lord Bacon firft pointed out its utility for medicine; he was the firft who invited phyficians to occupy themfelves attentively with it, and efpecially with the intention of difcovering means for preventing it, retarding it, even ftopping its progress, or re-eftablifhing the fubftances which had experienced it in their natural ftate.

Becher has made a remarkable table of its phenomena, and enunciated its grand effects in the order and fucceffion of the changes which the globe experiences: Stahl his commentator has added nothing to this table.

Pringle, an Englifh phyfician, has made a great number of experiments upon the fepticity and antifepticity of bodies, and has opened an immenfe career for the doctrine of antifeptics.

Citizen Giobert of Turin has repeated them and added to them feveral new ones.

A French lady, who has rendered herfelf eminent by a great number of fcientific productions, efpecially by her tranflation of Shaw's Courfe of Chemiftry, has given a numerous feries of experimental inquiries upon the fame fubject.

Macbride, a furgeon of Dublin, opened a new career immediately at the firft period of the difcoveries upon the elaftic fluids, in 1766.

He

He eftablifhed a new theory of putrefaction and the antiputrefcents, and attributed the firft to the difengagement of fixed air or the carbonic acid and the reftoration of the putrid matters to the reftitution of this principle. Though this theory has been difcovered to be erroneous, fince it has been known that the carbonic acid is not contained ready formed in the animal fubftances, and that it acts only as acid, not as principle of thefe fubftances in its antiputref-cent energy, yet the efforts of this able chemift have conducted us to new and ufeful confiderations upon this fpontaneous motion.

Boiffieu, Bordenave and Godart, in three Memoirs which gained the prize and the acceffit propofed upon putrefaction in 1767, by the Acadamy of Dijon, have alfo given ufeful obfervations upon this natural alteration, and have eftablifhed the bafis of doctrine for determining its caufe, phenomena and refults.

Finally, the labours of the moderns, efpecially Citizen Berthollet, and the data afforded by the pneumatic doctrine threw a new light upon this kind of fermentation and furnifhed a more exact explanation of its circumftances and products.

3. A firft fact which muft be infifted on, relative to putrefaction, is the extreme facility with which it eftablifhes itfelf, and the rapidity with which it goes through its periods in the animal fubftances: the caufe of this ftrong tendency, which is not found in the immediate materials of plants

plants, neceffarily depends upon the difference of nature which diftinguifhes thofe two claffes of organic compounds. It has been feen in all the preceding articles, that the animal compofition differs from vegetation by a greater number of conftituent principles, and by the proportion of thefe and the principles that are common to both. The azote added to the hidrogen, the carbon, and the oxigen, the fuperabundance of the hidrogen in the animal compounds, the phofphorus and fulphur which are very frequently combined with thefe firft principles, complicate their production and are the fource of the more numerous and more varied products which are obtained from them by the different agents to which they are expofed. The multiplied attractions which exift between their more numerous conftituent elements render their equilibrium more eafy to be deftroyed, and induce at the flighteft variation of circumftances, a decompofition, or change of nature, which quickly gives rife to other products more varied than are obtained from the vegetable fubftances. Life fupports and maintains with more or lefs force this equilibrium, this permanency of ftate, and it is in this that it confifts; but death permits the firft principles to re-act in particular the one upon the other. This fpontaneous re-action muft then be more prompt, more profound and more effective, as it takes place amongft fubftances more numerous, and by virtue of attractions more multiplied;

plied: it is therefore effential to the animal matters to be more putrefcible than the vegetable.

4. As whatever belongs to putrefaction prefents a great intereft to the fcience and to its numerous applications, the hiftory of this alteration requires to be exhibited with a method fufficiently ftrict to omit nothing effential, to place every fact, every truth in the fuitable light, to give to each the evidence and the force which belong to it, and to form of all a collective whole: I fhall therefore treat fucceffively and in a feries of numbers;

A. Of the preliminary conditions of putrefaction;

B. Of the general phenomena which accompany it;

C. Of the exiftence of particular phenomena which may ferve to characterize each animal matter;

D. Of the influence which the different media have upon it;

E. Of the different products to which it gives rife;

F. Of the laft refiduum which it leaves;

G. Of the caufes which determine it; of its nature, and of the principles in which it confifts;

H. Of its effects upon the living animals;

I. Of the means of remedying it;

K. Of thofe of preventing it;

L. Of thofe of ftopping it, or of the antifceptics;

M. Of

M. Of the principal applications which all these facts offer to medicine ;

N. Of the products which men have derived from it for their wants.

Each of these subjects requires only a mere sketch, as the present object is only to connect them with what has hitherto been set forth concerning the general characters of the animal matters, to derive from them a general notion concerning their chemical properties ; and as besides the generalities, new details will be given in the history of each animal matter in particular.

5. Though the absence of life has already been announced at least as a condition essential to putrefaction, as the energy and the power of the vital principle actually opposes this motion its existence is admitted only when this energy is weakened, and in some particular cases.

Death is not the only condition necessary to putrefaction ; there is also required the combination of several other circumstances without which it would not take place. These may be reduced to moisture and moderate heat. It is proved by a great number of facts that the dry animal matters do not putrefy ; the bones, dried meat, and anatomical preparations keep without alteration ; bones softened by water, the soft flesh, and especially the animal liquids, pass on the contrary rapidly into putrefaction ; it even principally follows the proportion of the quantity of water which exists in the animal

substances.

ſubſtances. It is no leſs aſcertained that there can be no putreſcence at the freezing temperature and below it; but that the ſeptic alteration commences at ſix or eight degrees above it; and proceeds in a progreſſion the more rapid, as the temperature of the ſubſtances which experience it is more elevated. This condition, however, has its limits; heat near the temperature of ebullition, and even that which exceeds from 45 to 50 degrees of Reaumur's ſcale, no more permits putrefaction than the cold; it even defends the animal ſubſtances againſt this motion, as it tends, either to dry them, or to condenſe their texture or coagulate their maſs, or to decompoſe them in another manner. The proportion of the elements which here act as conditions of putrefaction produce ſome modifications in it; water accellerates it by its quantity; the abundance of caloric ſometimes joins the effects of partial volatilization with thoſe of the putrid decompoſition. It was long believed that the contact of the air was neceſſary to putrefaction; but it is certain that as it takes place in a vacuum, and in ſmall proportions of air not renovated, the contact of the latter is only a condition which accelerates the putreſcence, not by the influence which it exerts of itſelf upon the animal ſubſtances, but merely by ſerving as a recipient for diſſolving and carrying off the materials that raiſe themſelves in vapour. It is to the ſame claſs that we muſt refer the diminution of preſſure, which ſome authors have conſidered as one

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of the caufes of putrefaction: we ought not to omit amongft the conditions of putrefaction the admixture of fermented matters, and efpecially of thofe that are putrefied with the frefh fubftances: this ferment acts by raifing the mafs, and accelerates and develops the putrefactive motion.

6. When the conditions of putrefaction, namely, an animal fubftance deprived of life, moift and expofed to a temperature above 10 degrees, are combined, this motion eftablifhes itfelf; the animal fubftance foftens if it was folid, or becomes thinner if liquid; its colour changes, and inclines more or lefs towards the red-brown, or the dark-green; its odour is altered, and after having been at firft faint and difagreeable, it becomes fetid and infupportable. An ammoniacal fmell foon mixes with the firft, and deprives it of part of its fetidity: this is only temporary, whilft the putrid odour exifting before it, ftill remains after it and fubfifts during all the phafes of the putrefaction. The liquids become turbid and filled with flakes; the foft parts are melted into a kind of jelly or putrilage; there is obferved a flow motion, a flight inflation which raifes the mafs, and which proceeds from bubbles of elaftic fluids, difengaged flowly and in fmall quantities at a time. Befides the general foftening there runs out a ferofity of different colour which conftantly augments; gradually the whole mafs melts, this flight inflation ceafes; the matter finks, the colour grows darker; at length the fmell becomes frequently

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as it were aromatic and approaches even to that which is termed *ambrosiacal* ; finally the animal ſubſtance diminiſhes in maſs, its elements evaporate and diſſolve, and there remains nothing more than a ſort of fat, viſcous earth, ſtill fetid.

The duration of this putrid decompoſition, though varied, preſents four very diſtinct periods which Boiſſieu has carefully diſtinguiſhed: the firſt, or that of the *tendency* to putrefaction, exhibits an alteration that is ſtill but ſlight; it preſents only the muſty ſmell, the ſoftening of the ſubſtance and a ſlight change of colour; the ſecond, or the *commencing* putrefaction, ſometimes affords ſigns of acidity: the ſoftening is more conſiderable; the ſeroſity begins to eſcape from the relaxed fibres; the colour is more altered and the fetid odour already putrid. In the third degree of the *advanced* putrefaction, the odour which is always fetid, is more or leſs ammoniacal; the matter diſſolved into putrilage is of a dark colour; it has loſt much of its weight by the diſengagement of a large quantity of volatile principles. The laſt degree, or the *accompliſhed* putrefaction, no longer preſents the ammoniacal odour; the fetidity is ſupportable, ſlight or none at all; an aromatic odour frequently ſucceeds in the place of it; the animal matter has loſt a great part of its volume and all appearance of organization; there remains nothing more than an earthy reſiduum, of a

blackiſh-

blackiſh-brown colour, fat to the feel, which in this ſtate is called *animal mould.*

7. Theſe phenomena vary according to the different animal matters; the difference of their nature and the different proportion of their principles are the ſource of them. It may even be ſaid that each animal ſubſtance has its different manner of comporting itſelf in putrefying. Hence, all the varied and diverſified ſcenes, which have been deſcribed by different authors, and of which we find a faithful account, both in the ſingular work of the phyſician Garman, entitled *De miraculis mortuorum*, in which are detailed the ſlow and ſucceſſive changes of all the parts of the human body in the cemeteries, and in the *Eſſay on putrefaction* by Madame Darconville. But as this object belongs to the hiſtory of each animal ſubſtance conſidered in particular, I mention it here only in order to eſtabliſh the principle of this variability of phenomena: it ſhall be treated of in each of the ſubſequent articles.

8. It is alſo a variation independent of the animal matter, and ſubjected only to that of the ſurrounding bodies, which I muſt here conſider in general under the title of the influence of the media in putrefaction. The ſingle obſervation drawn from the different cuſtoms of nations with reſpect to their dead, or from the poſition of the carcaſes of animals placed in different circumſtances, according to the places in which they ar deprived of life, ſufficiently proves

proves this remarkable variation. The bodies are feen altered in a different manner amongft the nations of the South Sea, who expofe their dead in the air, upon elevated places, in the cabins of boughs of trees of their morais, upon the fummits of trees; amongft the nations who immerfe them in the water; and amongft the more polifhed nations who immerfe them in the earth. I have faid elfewhere that the animal parts placed in water are converted there into fatty fubftance; an alteration nearly fimilar takes place in moift earth: but the greateft difference which is of importance to be confidered here, is that which takes place in the air, relatively to the phenomena which accompany putrefaction in clofe veffels. I have fuppofed this latter circumftance in defcribing (No. 6) the general phenomena of the putrid alteration. In the air, a portion of the entire animal fubftance is carried away and diffolved by the atmofphere; the products which are volatilized are equally carried away and diffolved by the air. The total and complete deftruction of the animal fubftance is effected with more or lefs rapidity. All the events of this decompofition are much nearer to one another, as the exterior agents contribute to feparate the elements of the matters which putrefy. Here the animal matter at laft completely difappears, fince after what the air receives of volatile principles, the fmall quantity of earthy refiduum which efcapes this aëriform folution penetrates gradually

gradually into the earth, where it is buried and carried away by the filtration of the waters.

9. Though we may rank amongſt the phenomena of putrefaction, the matters which are diſengaged from the putreſcent animal ſubſtances, I ſhall conſider them here in particular as products, becauſe they proceed from the action of this motion itſelf, and becauſe it is important to know them with more accuracy and preciſion than the mere inſpection or even obſervation of theſe phenomena would permit. In order to determine the nature of theſe phenomena, to follow with attention the ſeries and the epochas of their diſengagement, and conſequently to know in what the decompoſition of the animal matter conſiſts, it was neceſſary that a conſecutive analyſis of the putrid vapours, an attentive examination of the putrefied matters, ſhould ſupply the place of the theory which had attempted to divine their characters. Thus it was long believed that the ammonia or volatile alkali was the ſole product of putrefaction, and it was on this account that it had been called *alkaline fermentation*, in oppoſition to that which gives riſe to the acetous acid: but though ammonia is indeed one of the principal products of this ſpontaneous motion, it is not the only one; there are others, the production of which precedes, accompanies, or follows its production, and which deſerve to be known and ſtudied with equal attention. There are even ſome animal

animal matters the feptic decompofition of which commences with an acidification.

We fhould have only an imperfect and fuperficial notion of thefe products, if, after being affured that they are not the fame nor in the fame proportions with the different animal matters, we did not endeavour to approximate all thefe various products, to collect under a fingle point of view all the fubftances afforded in the putrefaction of the different animal compounds, and thereby embrace the totality of thefe products.

It is then found that the animal fubftance fucceffively gives rife, in its putrid decompofition, to carbonated, fulphurated, and phofphorated hidrogen gafes, which carry and propagate its infection far and wide; to water, which is difengaged in vapour, to ammonia, and to carbonic acid gas. All thefe bodies efcape, are diffipated and volatilized; they carry off with them combined two and two together, the principal primitive materials of the animal compound. Other products, formed at various periods, as acceffary circumftances of the compofition of each animal matter, differ from the preceding by their fixity, and remain in this matter more or lefs folid and fixed: fuch are the zoonic acid, a fat matter, a kind of foap formed by this fat and ammonia; fuch is alfo the nitric acid, frequently formed in this decompofition, and fixed by an earthy or alkaline bafe; fuch finally is the unctuous mould which remains after the fepara-

tion

tion and the difengagement of the preceding products. Thus the animal matter is gradually feparated, divided and deftroyed: we fhall foon fee how thefe products are formed and fucceed each other.

10. It is efpecially ufeful to diftinguifh, amongft the products of the putrefactive motion, that which is its laft refult, that which, after the difengagement of all the volatile materials, remains fixed, and conftitutes the refiduum. Its fmall quantity, its contracted volume, its earthy form very remote from organization, of which it prefents nothing more than the wrecks or the moft folid matter, have at all times fixed the attention of the philofopher. The remains of a large mafs of organized matters, of which it forms only fome hundredth parts, it has long been confidered as a particular earth, which was diftinguifhed by the name of animal earth. But this denomination, derived from its pulverulent ftate, its infipidity, its inodorous quality, as well as its fixity and infolubility, is inaccurate and erroneous, fince this refiduum, this animal mould, contains, befides the acids and the earths combined in the faline ftate, a portion of fat coally matter, which, when diftilled, ftill yields oil, carbonate of ammonia, and leaves a coal charged with earthy phofphates. The fixed, faline, earthy and metallic matters which conftitute the nature of this refiduum, retain for a long time a portion of oily fubftance more or lefs concrete, which is deftroyed only very flowly; and

and in order that they may be reduced to the pure faline and earthy ftate, analogous to the afhes which remain after combuftion, it almoft always requires a long feries of years. Thus carcafes buried in the earth are not reduced to their dry fkeleton, and do not lofe the laft remains of their foft parts, till after a lapfe of time, which generally exceeds feven years, and which is fometimes prolonged to more than thirty. The excavations in the ground of the cimetery of the Innocents at Paris have proved this to me in an inconteftible manner; it is eafily conceived that the proportion and the nature of this refiduum correfpond entirely with thofe of the fixed matters, which formed conftituent parts of the animal compounds, and that they muft vary according to each of thefe compounds.

11. As we have now feen the conditions of putrefaction, the phenomena which it prefents to the obferver, the general influence which it receives from the mediums in which it acts, the different products which it affords, and the refiduum which it leaves, it is time to occupy ourfelves with its intimate nature. It is not enough to have confidered it as a flow decompofition, as a fpontaneous analyfis, as a deftructive fermentation of the organic compounds, becaufe it has all the characters of the inteftine motions which are defignated by this name in chemiftry; it is neceffary that we fhould penetrate more intimately into its caufe, to afcertain and explain its mechanifm. It is evident that it confifts in

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a change effected by a ſum of attractive forces ſuperior to thoſe which keep the principles of the putreſcent ſubſtance united. Theſe principles are, as we know, hidrogen, azote, carbon and oxigen, with which are frequently aſſociated ſulphur, phoſphorus, and different kinds of phoſphates.

It is evident that, in putrefaction, part of the hidrogen unites with the azote to form ammonia; another part of the hidrogen combines with a portion of oxigen with which it conſtitutes water; that a certain quantity of carbon, combined with a relative quantity of oxigen, gives riſe to carbonic acid; that a portion of azote united with a third quantity of oxigen produces nitric acid; that a combination of hidrogen, carbon and azote forms the volatile or the fixed oil, according to the proportion of theſe principles; that another combination between the ſame matters and oxigen compoſes the zoonic acid; and that finally, the ſaline, earthy, and metallic ſubſtances, being unalterable, or little alterable by the inteſtine motion of putrefaction, remain untouched and paſſive in the laſt reſidue of this ſpontaneous motion, carried to its *maximum*.

It is no leſs evident that theſe matters or new compounds, which did not exiſt originally in the animal ſubſtances, unite two and two together, the ammonia and the carbonic acid, the ammonia and the zoonic acid, the ammonia and the oil which it reduces to the ſaponaceous ſtate,

ſtate, and are diſengaged in this form in the air, or diſſolved in the water. All theſe new compoſitions, which are leſs complex than the primitive compound which gives riſe to them, and which are the products of its ſlow diſſolution and the indications of its deſtruction, are the conſequence of numerous attractions which act amongſt the multiplied principles of the organic compound deprived of life.

We may comprehend in a general formula the totality of all theſe attractions, and expreſs with preciſion what takes place in putrefaction, by ſaying that the ſum of the forces which tend to unite the hidrogen with the azote, the oxigen with the carbon, the carbonic acid with the ammonia to form the ammoniacal carbonate, and the hidrogen, the carbon, and the oxigen to produce oil; this latter with the ammonia to conſtitute a ſoap; and finally, the hidrogen with the oxigen to produce water, and the latter with all the preceding compounds,—that this whole ſum is ſuperior to the ſum of the forces which retain in quaternary combination the hidrogen, the azote, the carbon and the oxigen, to conſtitute the animal compound.

We have here repreſented only the alterant action of theſe forces, and the putrefactive effect which reſults from them in cloſe veſſels, into which nothing extraneous to the organic ſubſtance can enter, and from which nothing can eſcape; for though the reſults are ultimately identic, they take place in a very different

 manner

manner in the midſt of the atmoſpheric air. In the latter circumſtance, a part of the animal ſubſtance is diſſolved and carried off conjointly and ſeparately by the air and by the water; the ammonia and the carbonic acid are volatilized as faſt as they are formed; a portion of carbonated hidrogen is volatilized by the alteration of temperature: and there is formed neither fat matter nor ammoniacal ſoap.

Thus may be explained in a ſimple manner the phenomena and the products of putrefaction; and thus its conditions, its varieties, its duration, &c. may be comprehended. It was natural to conſider them as inexplicable, as long as the nature of its products, that of the water, of the ammonia, of the oils, and of the acids, were involved in an obſcurity which neceſſarily extended itſelf over the progreſs and the mechaniſm of this kind of fermentation. This obſcurity has, as we ſee, been diſpelled by the efforts of the pneumatic chemiſtry which has left nothing unintelligible in the knowledge of this ſpontaneous decompoſition. This is one of the fruits which we owe to its progreſs and its happy revolution.

12. Amongſt the phenomena dependant upon putrefaction which it is of importance to conſider, muſt be reckoned the dangerous effects which it produces upon living animals. If we except a very ſmall number, belonging to the laſt claſſes of theſe beings and endowed with the leaſt ſenſibility, there are none which an animal matter in the ſtate of putrefaction does not deter

and

and repel from the place where this ſcene of death and deſtruction is exhibited. By the diſguſt with which it inſpires them, by the haſty flight which it occaſions, it is eaſily conceived that this phenomenon is inimical to life, and that it threatens it with remarkable energy. Accordingly, the greater number of animals cannot feed upon animal matters putrefied to a certain degree; and though ſome of them, being indolent and ferocious at the ſame time, devour carcaſes already tainted, none make them their food when the putreſcence is too far advanced. We know the averſion and diſguſt which all mankind have againſt corrupted animal matters, the diſagreeable effect which they produce upon their organs, and the repugnance which their ſenſe of ſight and ſmell experience at the mere aſpect of theſe matters. Frequently the putrid miaſmata or the gaſes which are exhaled from bodies in the ſtate of putrefaction, are ſo deleterious, that men and animals are deprived of ſenſe by their contact. When they do not produce this ſudden effect, they occaſion putrid diſeaſes in ſuch as are expoſed to them. Some individuals contract external affections, carbuncles, malignant and gangrenous puſtules by the corruptive action of theſe vapours; others are influenced by them in a much more dangerous manner, for beſides a conſiderable proſtration of the powers of life, they become affected with putrid fevers of the moſt malignant character. It is not yet known what is the nature of the

putrid

putrid gas from which theſe terrible effects ariſe: it is not the azotic gas, as ſome modern phyſicians have thought, who on that account have given it the name of *ſepton* or rather *ſeptic gas*. There is reaſon to ſuſpect that they ought rather to be attributed to the action of the putrefied animal matter itſelf, which being diſſolved in the gaſes exhaled during its putrefaction, carries into the organs which are the focus of life its benumbing or debilitating principle, and pours into the torrent of the animal humors the putrid germe or ferment, which they are unfortunately ſo much diſpoſed to receive.

13. Science, whilſt it enables us to aſcertain the ſource and the cauſe of theſe terrible effects, furniſhes us with arms for preventing or determining its influence. Two means preſent themſelves, ſuggeſted by reaſon and confirmed by experience: the one, which belongs to the police and the wiſdom of government, conſiſts in removing from populous places, particularly from large towns where the accumulation and crowded ſituation of the inhabitants is already a pre-diſpoſing cauſe of putrid diſeaſes, the ſources of infection and putrefaction. To aërate the habitations, to eſtabliſh a frequent ventilation in them, to cover the common ſewers, to remove ſinks of all kinds, to eſtabliſh burial places out of the towns, to kindle large wood-fires in ſuch ſituations that the wind may carry the ſmoke into the places which we wiſh to preſerve, to obtain a profu-

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ſion of freſh and running water in open canals, and eſpecially to cauſe it to aſcend in fountains or precipitate itſelf in caſcades; theſe are the grand means of preventing putrefaction or at leaſt of repelling its invaſions. The other means, more confined in its application, and practicable only in ſmall ſpaces or in circumſcribed places, has for its object to deſtroy the putrid miaſmata themſelves, to fetter their activity, and to neutralize their virulence. This effect is obtained by the diſengagement of the muriatic acid in gas, and eſpecially by the oxigenated muriatic acid, which I conſider, and which I propoſed ſome years ago, as the greateſt external antiſeptic, becauſe it attacks and deſtroys the animal combination which conſtitutes the virus. Its advantages and uſe in this point of view will be the better underſtood, in proportion as the principles of chemiſtry ſhall be diffuſed in the work-ſhops and become familiar to manufacturers and artiſts.

14. Art has always ſought the means of preventing the putrefaction of animal matters, and defending them againſt corruption. The number of means and matters of this kind which it has diſcovered is very conſiderable; the principal are, as is eaſily conceived, all the proceſſes which deſtroy the conditions that give riſe to it. Thus the deſiccation of animal matters, the privation of water, refrigeration, or preſſure, are the firſt and moſt certain, becauſe by their ſimple influence, they make the

the caufes difappear which develope putrefaction. Many fubftances with which the animal matters are enveloped or which penetrate their texture anfwer the fame purpofe. The acids, the falts, the aromatics, fugar, the fixed and volatile oils, the refins, camphor, the powder of dry and odorous plants, of acrid refinous bitter woods; charcoal, generous wines, alcohol; the bitumens; particularly poffefs this property: accordingly, thefe are the fubftances which are employed with the moft fecurity for preferving animal matters in the art of embalming, falting, in condiments, macerations in vinegar, &c.

15 Medicine has been occupied with a particular intereft in the refearch of fubftances capable of retarding or ftopping the progress of putrefaction which frequently manifefts itfelf in fome parts of the difeafed human body; it has called them *antiputrefcents* or *antifceptics*. On comparing them with thofe already indicated we find great analogies between them.

Godart obferves that all the poffible antifeptics may be reduced to three claffes:

A. The refrigerants, which comprehend all the means of diminifhing heat, the great influence of which upon putrefaction we already know. He ranks in this clafs: cold, the aqueous fubftances, the farinaceous matters, the acids, and the fedative.

B. The ventilants or thofe which diffipate the

the putrid miafmata, are the agitation of the air, the evacuents, the cordials;

C. The corroborants, which condenfe or contract; amongft which he enumerates the acerb, the aftringent, and the bitter fubftances.

Bordenave has referred the medicinal antifeptics to fix claffes; namely, the antirelaxants, the ftimulants, the aftringents, the balfamics, the deficcants and the cauftics.

Boffieux, in a very extenfive and very methodical table, has prefented their feries diftributed into a great number of ingenious divifions, which it is not my object here to exhibit. In all the confiderations relative to thefe agents, there have efpecially been diftinguifhed the fulphuric acid, the carbonic acid, the vegetable acids, the Peruvian bark, Scorduim, Guaiacum-wood, camphor, tannin, the gall nut, alcohol, the metallic falts and their folutions: fome have even gone fo far as to pretend to reftore flefh already in a very advanced ftate of putrefaction to its original condition. Macbride has more efpecially attributed this effect to carbonic acid, becaufe putrified flefh immerfed in it refumes a part of its colour and confiftence: but it is very evident that this is an exaggerated pretenfion, and that nothing more has been effected than the feparation of the exterior part, the moft advanced in putrefaction, from the ftill found portion; for fcience teaches us that it is impoffible to form anew an animal matter that has been deftroyed, and that we cannot in

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this respect surpass Nature, who herself is subjected to the impossibility of making a retrogade step in this putrefaction.

16. After all the preceding considerations, it cannot be doubted that putrefaction is a slow decomposition, a kind of spontaneous analysis effected by virtue of complicated attractions, existing between the numerous principles of the animal matters, namely, the hidrogen, the azote, the carbon, the oxigen, the sulphur, and the phosphorus; that the motion, which is excited amongst these principles, and which has great analogy with a fermentation, (whatever Boerhaave and his school may say of it, who did not admit of this analogy) is in some measure ordained or willed by Nature; that it is the means which she employs in order to destroy the animal organization and composition, when the animal matters, deprived of life, can no longer serve in the animated form, for the exercise and support of which those primitive matters had only been lent them according to the immutable laws established in the order of the universe; that Nature thus takes back those principles, which are no longer employed in the phenomena of life, and restores to other more simple combinations the portion of matter which constituted the bodies of the animals. Thus, by the admirable order which exists in the economy of Nature, the most complicated phenomena which represent during life the master-piece of organization and the most numerous chemical phenomena, are

are reduced after death into more ſimple compounds, almoſt all binary,—and by the aid of the putrid decompoſition, return into the claſs of the minerals, are thus reduced almoſt to the ſtate of elements, are diſſolved in the water, diffuſed in the earth, and ſerve for new combinations. Thus in ſtudying the properties and chemical characters of animal ſubſtances, we are led back to the ſimple and primitive ſubſtances with which we commenced the ſtudy of the natural ſubſtances. This effect, this tranſition, this circulation of ſubſtances, which had long ago been diſcerned by the ingenious Becher, were called by this chemiſt the circle of the eternal motion, *circulus æterni motus.*

17. Men have at all times availed themſelves of the phenomena and products of putrefaction, and have in ſome ſort derived the ſupport of their exiſtence from the very womb of death and deſtruction. The animal matters corrupted and reduced to the ſtate of mould are employed with much advantage as manures; in order to diminiſh their too hot and too nouriſhing properties, they are not diſtributed in the ground which is intended to be manured, until they are almoſt entirely deſtroyed. They are ſometimes alſo prepared by particular proceſſes of deſiccation and concentration, as is done in the vicinity of Paris with the filth of the privies, in order to convert it into a dry and very fecundating powder, which is called *poudrette.* In other places, by cauſing the animal matter to putrefy with vegetable

vegetable fubftances, or by moiftening the latter, depofited in dry layers and expofed to decompofition under fheds with animal liquids, urine, the waters of kitchens, of fhambles, &c. the production of nitre is accelerated, by means of the azote which thofe liquids afford. In fome manufactories animal fubftances, and efpecially corrupted urine is employed for extracting with facility very abundant quantities of carbonate of ammonia. Laftly, we might avail ourfelves of the difcovery which I have made of the converfion of the bodies of animals into fat in ftagnant waters or in moift earth, in order to prepare with offals that hitherto have been applied to no ufe, fats which would be ufeful in a great number of the arts. We are even affured that Englifh induftry has already availed itfelf of this difcovery, and that a concrete oil is prepared in England by this mode of putrefaction.

18. There are fome circumftances which, by oppofing more or lefs powerfully the putrid decompofition of the animal matters, leave them only the poffibility of being converted into fubftances of a different nature, and fufceptible of keeping for a long time in this ftate. In this clafs are to be ranked; 1. dead bodies deficcated by a dry and glowing atmofphere, or by an arid and violently heated fand; 2. the natural mummies, and the mummies which art, at the fuggeftion of a religious fentiment, or of a refpectful attachment to the remains of beloved objects,

prepares

prepares by the aid of all the prefervative means and embalment; 3. bodies and their organs prepared by different anatomical means; 4. hair, filk, feathers, fkins, prepared and preferved in folid and durable textures; 5. fmoaked, falted flefh, which has become hard and as it were of a woody confiftence, in which ftate it keeps for a long time without alteration; 6. bones, horn, fcales, dried and converted into utenfils or machines of various forms and various utility; 7. bones impregnated with different minerals in the bofom of the earth, and efpecially thofe which are converted into turquoife. There is alfo reafon to believe that a portion of the remains of animal fubftances, fo abundant in the water of the fea, and of large rivers, enters by their more or lefs advanced decompofition, and by affuming the character of oily matter, into the formation of the bitumens. As to the petrified animal fubftances, which are generally ranked in the fame feries with the preceding fubftances, thefe are either folids impregnated with calcareous difpofition, or merely moulds filled with filiceous matter.

THIRD ORDER OF FACTS

OF THE PROPERTIES OF PARTICULAR ANIMAL SUBSTANCES.

Article I.

Of the Comparifon and the Claffification of the different Animal Subftances.

Section I.

Of the different Modes of their Claffification.

1. IT is not fufficient to have confidered the animal fubftances in general, and inveftigated the characters which diftinguifh them from the vegetable matters. This firft inquiry ought only to be confidered as an introduction to the hiftory of thefe fubftances in particular. It ought to precede and to elucidate it; but it cannot be fubftituted in place of it; it has only the advantage of rendering more intelligible the examination of their properties, and diminifhing the extent of the details which this examination would have required, if the expofition of the general properties of the animal matters had not determined their nature.

2. Though it may appear, at the firft glance, a matter of indifference whether the chemical

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hiſtory of the animal matters be treated in ſuch or ſuch an order, it is however neceſſary to decide in the choice of this order, and on this account it becomes neceſſary to indicate and compare with each other the different methods of claſſifying theſe ſubſtances. We know in the firſt place that they may be conſidered as a kind of immediate materials of animals, and that in this point of view it would be poſſible to divide or rather diſtribute them, as has been done with reſpect to theſe vegetable matters, into ſuch as are ſoluble in water, into oily, ſaline, ſolid and inſoluble ſubſtances. But this firſt kind of diviſion is very imperfect and very inaccurate, as it is far from comprehending all the ſubſtances which compoſe the bodies of animals.

3. The diviſion of theſe ſubſtances into liquids and ſolids is alſo inſufficient. Frequently the works on chemiſtry have followed the diviſion into recrementitious liquids, ſuch as the blood, the lymph; excrementitious, ſuch as the urine, &c. and excremento-recrementitious, as the bile, the ſperm, &c. We have no greater reaſon to be ſatisfied with this claſſification, which preſents nothing well fixed and accurate. Theſe matters might be arranged, according to their chemical nature, into four claſſes, according to the ſuper-abundance of one or other of the principles which enter into their compoſition. Thus we ſhould have:

A. Hidrogenated or oily animal ſubſtances; ſuch as the fat, the cerumen, the bile.

B. Oxigenated

B. *Oxigenated* animal fubftances or oxides; the albumen, the lymph; in thefe would be comprehended the lymph, the water of the interior cavities, the cerebral pulp.

C. *Carbonated* animal fubftances; the gelatinous or mucous, comprehending the membranes, the aponeurofes, the tendons.

D. The *azotated* animal fubftances, fibrous or flefhy; fuch as the mufcles, certain vifceral parenchymata.

E. The *acid* animal fubftances; the uric acid, the formic acid, the bombic, &c.

F. The *faline* aqueous animal fubftances; as the aqueous and the vitreous humor, the tears, the faliva.

G. The *phofphated* animal fubftances, efpecially thofe in which the phofphate of lime predominates; in this clafs would be placed the nails, the horns, the hair, the bones.

H. Finally, the *mixed* animal fubftances, containing feveral of the preceding materials; this laft clafs would belong to the blood, the milk, the fperm, the urine.

4. The chemical method which I have juft fketched would be beyond all contradiction the moft perfect, the moft exact, and that which ought to be preferred to all others, if the animal analyfis were more advanced, and if the comparative nature of the animal liquids and folids were better known. For not to mention that all thefe matters have not yet been fufficiently analyzed to enable us to rank them in one or other of the eight claffes

claffes that have been indicated, I cannot prefent this divifion into eight claffes, except as a very imperfect attempt, which, though not purely hypothetical, is not fufficiently well founded upon experience for it to be adopted and confidered as proper to afford a right notion of the comparative nature of the different animal compounds. I give it here rather in order to fhow what chemiftry may hope to attain in this refpect, than as a true method of claffification. Accordingly, I fhall not adopt this method in the folowing articles, becaufe not yet fufficiently exact.

5. The following is the order which the actual ftate of chemiftry and of animal phyfics permits me at prefent to adopt. I fhall divide the animal fubftances into three claffes: in the firft I fhall rank thofe which are generally diffufed throughout the whole body of animals; in the fecond, thofe which belong to fome particular region or organ, and in the third thofe which are found only in fome orders of animals, whilft the fubjects of the two firft are found generally in all. The animal matters generally diffufed are either liquid, fuch as the blood, the lymph, the fat, the tranfpiration, the humor of the interior cavities of the fynovia; or foft, as the cellular texture, the membranes, the tendons, the aponeurofes, the ligaments, the glandular texture, the mufcles, the fkin and the epidermis; or folid, as the horny texture of the hair, the cartilaginous texture, the offeous texture.

6. The fecond clafs of animal matters, belonging to the different regions of the bodies of animals, comprehends in four divifions :

A. The fubftances contained in the cranium.

B. Thofe which the cavities of the face prefent.

C. Thofe which are found in the thorax.

D. Thofe inclofed in the abdomen.

The matters belonging to the cranium are the cerebral pulp, the nervous fluid, the liquor of the ventricles of the brain, the pineal concretions.

Thofe of the face are the aqueous humour of the eye, the vitreous humour, the cryftalline humour, the tears, the nafal mucus, the mucus of the mouth, the mucus of the tonfils, the faliva, the falivary calculi, the tartar of the teeth, the cerumen.

To the matters belonging to the thorax are to be referred the tracheal and bronchial mucus, the gas proceeding from the lungs, the pulmonary concretions and the milk.

The fubftances contained in the abdomen comprehend the gaftric juice, the pancreatic juice, the bile and the biliary calculi, the inteftinal juice, the chyle, the excrements, the inteftinal gafes and the concretions of the inteftines, to which are to be added the liquor of the amnios, the fuperrenal liquor, the meconium, liquids peculiar to the fœtus, and finally, the urine, the urinary calculi, the juice of the proftata, and the fperm.

7. The

7. The third clafs of animal matters comprehends thofe which are peculiar to fome orders of animals, and which are frequently employed in the arts; and as thefe orders are feven in number, it is divided in the fame manner.

The firft divifion contains thofe which are particularly furnifhed by the mammalia, fuch as ivory, hart's horn, horn, wool, mufk, civet, ambergreafe and the bezoars.

The fecond divifion is referved for thofe which are obtained from the birds; namely, the eggs, the feathers, the dung, and the membrane of the ftomach.

The third prefents the product particular to the amphibia, the viper and its poifon, the fkinc, the lizard, the toad, the tortoife and its fhell.

The fourth is appropriated to fome productions peculiar to fifhes, ifing-glafs, fifh-oil, the fcales of the blay, and the bones of the head of feveral of thefe animals.

To the fifth I refer fome matters belonging to the teftacous fifh; the bones and the ink of the cuttle fifh, pearl and mother of pearl fhells.

In the fixth I place thofe which are extracted from infects and worms, the honey and the wax of bees, cantharides, wood-lice, ants, their acid and lac, the bread of the ant, filk, cochineal, kermes, crab's eyes, the lumbrici.

Finally, the order of Zoophytes affords four particular animal matters; namely, coralline, coral, the madrepore, and the fponge.

8. In order to exhibit the collective whole of this division of the animal substances, I here present a table in which the relation, the difference and the classification will appear at the first glance. It will there be seen that there are fifty-three different substances in the two first classes, and forty-one in the third; the importance of the fifty-three first obliges me to treat of them in a pretty considerable number of separate articles. As to those of the third, which present more or less resemblance with those of the two first classes, I shall content myself with giving an account of them in the seven articles which will comprehend the particular products formed by the seven orders of animals.

TABLE

Containing the Division and the Classification of the Animal Matters.

All the Animal Matters, considered in their mutual relations, may be divided into the three following Classes.

FIRST CLASS.

Animal Matters belonging to the whole Body.

Liquids,	Blood, - - -	1
	Lymph, - - -	2
	Fat, - - -	3
	Transpiration, - -	4
	Humor of the internal cavities,	5
	Synovia, - -	6

Soft parts. -	Cellular texture, -	7
	Membranous texture,	8
	Tendinous texture, -	9
	Aponeurotic texture,	10
	Ligamentous texture,	11
	Glandular texture, -	12
	Mufcular texture, -	13
	Cutaneous texture, -	14
	Epidermoid texture, -	15
Solids. -	Hair, - - -	16
	Cartilage, - -	17
	Bone, - - -	18

SECOND CLASS.

Animal Matters belonging to fome particular Regions of the Body of Animals.

To the cranium.	Cerebral pulp, -	19
	Nervous fluid, -	20
	Liquor of the ventricles,	21
	Pineal concretions,	22
To the face.	Aqueous humor, -	23
	Vitreous humor, -	24
	Cryftalline humor, -	25
	Tears, - - -	26
	Nafal Mucus, - -	27
	Mucus of the Mouth,	28
	Mucus of the tonfils,	29
	Saliva, - - -	30
	Salivary calculi, -	31
	Tartar of the Teeth,	32
	Cerumen, - -	33

To the thorax.	Tracheal and bronchial mucus, - -	34
	Gas of the lungs, -	35
	Pulmonary concretions,	36
	Milk, - - -	37
To the abdomen. -	Gaſtric juice, - -	38
	Pancreatic juice, -	39
	Bile, - - -	40
	Biliary calculi, -	41
	Inteſtinal juice, -	42
	Chyle, - - -	43
	Excrements, - -	44
	Gas of the inteſtines, -	45
	Inteſtinal concretions,	46
	Liquor of the amnios,	47
	Superrenal liquor, -	48
	Meconium, - -	49
	Urine, - - -	50
	Urinary calculi, -	51
	Juice of the proſtata,	52
	Sperm, - -	53

THIRD CLASS.

Animal Matters belonging to each of the Seven Orders of Animals in particular.

To the mammalia.	Ivory, - - -	54
	Hartſhorn, - -	55
	Horn, - - -	56
	Wool, - - -	57
	Muſk, - - -	58
	Civet, - - -	59
	Caſtor, - - -	60
	Ambergris, - -	61
	Spermaceti, - -	62
	Benzoar, - -	63
To the birds.	Eggs, - - -	64
	Feathers, - -	65
	Dung, - - -	66
	Membrane of the Stomach,	67
To the amphibia.	Viper, - - -	68
	Toad, - - -	69
	Skink, - -	70
	Lizard, - -	71
	Tortoiſe, - -	72
To the fiſhes.	Iſinglaſs, - - -	73
	Fiſh-oil, - - -	74
	Fiſh-ſcales, - -	75
	Fiſh-bones, - -	76

To

To the teſtacea.	Bones and ink of the cuttle-fiſh, - - -	77
	Pearl and mother of pearl,	78
	Shells, - - -	79
To the inſects and worms.	Honey and wax, -	80
	Cantharides, - -	81
	Wood-lice, - -	82
	Ants, - - -	83
	Lack, - - -	84
	Ant-bread, -	85
	Silk, - - -	86
	Cochineal, - -	87
	Kermes, - -	88
	Crabs'-eyes, - -	89
	Lumbrici, - -	90
To the zoophytes.	Coralline, - -	91
	Coral, - - -	92
	Madrepores, - -	93
	Sponges, - - -	94

ARTICLE

Article II.

Of the Blood.

Section I.

Hiſtory and Analyſis of the Blood.

1. THE blood, this red and hot fluid contained in the arteries and the veins, neceſſary to life, moved inceſſantly by the circulation, moiſtening all the organs, conveying into them heat and motion, diſtributing nouriſhment, acting an important part in the animal economy, has always been conſidered as the principal object of the ſtudies and the reſearches of the anatomiſt, the phyſiologiſt, and the phyſician. The ſubject of many important inquiries, of a multitude of experiments, it is ſtill, notwithſtanding the ſtudies of the philoſophers and the numerous obſervations of the phyſicians, an inexplicable enigma; and though more advanced in the knowledge of its properties, modern phyſics are very far from the point at which they muſt arrive in order to explain its real influence upon the phenomena of life. Its effects appear to be extremely complicated, its uſes multiplied ad infinitum; we ſee it preſide in ſome meaſure over all the functions; reſpira-tion

tion acts eſpecially upon it; the circulation is performed in order to convey it to all parts of the body; it is this which warms the whole animal ſyſtem; it cauſes the heart to move; it is the common ſource of all the ſecretions; it nouriſhes all the organs; it affords the recrement as well as the excrement; it repairs the waſte of all the parts; the lymph is one of its productions; the tranſpiration eſcapes from the cutaneous extremities of the canals which tranſmit it; it exiſts every where, it vivifies all the organic ſyſtems, the totality of which conſtitutes the animal machine; it muſt therefore offer to the philoſopher the ſeries of all the problems preſented to him by the animal economy.

2. Accordingly the number of learned men who have occupied themſelves with it is immenſe: ſome have examined its chemical properties; its mere quantity, its weight, its motion have been the object of much inveſtigation, which is not even yet entirely terminated. Even its proportion is not known; and authors have varied amongſt themſelves from eight pounds to twenty-eight pounds for the quantity contained in the body of a man of the middle ſize. Some have ſaid that it forms a fifth of the weight of the body, others only a twentieth. Some reckon it at a ſixteenth, a fifteenth, &c. It is commonly believed to be diſtributed in ſuch a manner that the veins contain nine and the arteries four parts. When we read in the learned work on phyſiology by Haller, the opinions of

of Harvey, Allen, King, Lifter, Drelincourt, Hales, Moor, Siegel, Primerofe, Kiel, Lobb, Lower, Quefnay, F. Hoffmann, upon the proportion of the blood in the human body, we fee how many difficulties and uncertainties attend the precife knowledge of its moft fimple properties. If we alfo remark in the fame author what diverfity of opinion has prevailed in the fchools concerning the difference of colour and temperature of the arterial and the venous blood, a queftion which neverthelefs feems eafy to be folved by mere infpection or by fimple experiments; if we compare the celebrated names of Galen, Erafiftratus, Aretaeus, Harvey, Lower, Mayow, Schreiber, Willis, Swammerdam, Duverney, Verheyen, Helvetius, Michelotti, Lancifi, Sevérini, Chefelden, Hamburger, Martine, Pitcairn, Jurin, De Haen, who have not been able to folve thefe problems with accuracy, and who have left the refult uncertain, notwithftanding an affiduous labour of feveral ages: we fhall be able to conceive with what fetters the human underftanding has been fhackled in its progrefs relative to this important part of phyfiology.

8. Hence, many able and learned phyficians, deterred for a long time by this unfuccefsfulnefs of the phyfical fciences, and not trufting more to the experiments of the chemifts, have thought it neceffary to take a different courfe in order to appreciate the properties of the blood. Founded upon the phenomena which it prefents in the living animals, they have confidered

fidered it as an affemblage of all the animal liquors, as a refervoir of all thofe materials, a folution of all the folid parts, a fort of liquid flefh, of plaftic animal mucilage, hot, boiling, moved in torrents, tending to all parts of the body, communicating with all, affuming a particular nature in each organ and even in the vicinity of each of them, diftributing into all their cells the materials which muft ferve for their reparation, remaining fluid only by the effect of motion, precipitating fibres already become folid by a flight agitation, difpofed to affume the ftate of concrete mafs when its motion is retarded, animated by a particular or vital power which difappears in death, and which can no longer be perceived in it when it is feparated from the living animals. This feries of notions they have called the medicinal analyfis of the blood. But whatever ingenuity Bordeu has difplayed in the expofition of thefe ideas, we find in them neither precifion, nor accuracy, nor pofitive knowledge; but merely vague notions, the fruits of an active imagination, perhaps liable to the fame reproach which he caft upon the chemifts.

4. Notwithftanding the little confidence which the phyficians (indeed amongft thofe who though otherwife poffeffed of much learning and talents had not acquired a fufficient ftock of chemical knowledge) have teftified for the examination of the blood by the means of this fcience, a great number of chemifts, alfo belonging

ing to the clafs of the phyficians, and confequently competent to balance the opinion of the firft, have occupied themfelves with the chemical analyfis of the blood.

After the firft ftill very inaccurate attempts of Barbatus and Bohnius in the feventeenth century, after the difputes of Vieuffens, of Willis, &c. whether to admit or reject the prefence of a pretended acid in the blood; Ruyfch treated experimentally the concrefcibility of the blood, the art of obtaining from it fibres, textures, membranes; Lewenhock and Hartfoeker inveftigated its nature with the microfcope, and defcribed in it a compound globulous ftructure, of which Boerhaave has made an ingenious ufe, though it is nothing more than a fort of microfcopic fiction.

Hales wrote learnedly upon its analyfis by fire, and upon the elaftic fluid difengaged from it by this agent.

Lemery found it to contain iron ready formed, the proportion of which was determined by Menghini.

Hoffmann was one of the firft who defcribed the chemical characters of its different parts feparated fpontaneoufly.

Langrifh, Cheyne, Swencke, have given analyfes of it that are almoft complete for the time in which they wrote.

Gaubius examined it after Boerhaave with much greater accuracy than his predeceffor.

Rouelle

Rouelle the younger firft fhowed with precifion the falts that are contained in it.

G. Hewfon defcribed feveral of its properties with fagacity.

Bucquet, immediately after Rouelle, particularly ftudied the chemical characters of the coagulum and of the fibrous part.

Dehaen has fhown that its coagulation, its ferum, its buffy coat, vary according to the circumftances of its extraction in venefetion.

Cygna did all in his power to difcover the caufe of its rutilation by the air, which has fince been placed out of doubt by the experiments of Lavoifier, Menzies and Godwyn.

Crawford has determined the difference of the fpecific heat of the arterial and of the venous blood.

Citizens Deyeux and Parmentier have examined with much attention the different materials of the blood, the ferum, the fibre, the coagulum, and fome of its morbid alterations.

I have likewife occupied myfelf with it, at different times, during fifteen years paft; I have afcertained the prefence of the gelatin in it, the action of a violent fire in open veffels, its difference in the fœtus, &c.

The rapid fketch which I have juft prefented is fufficient to prove that much labour has been beftowed upon the nature of the blood; I muft terminate it by obferving that though chemiftry has not yet refolved all the problems which this fluid prefents to it, it has at leaft fhown the

path

path that muft be followed in order to find their folution, as the following details will prove.

SECTION II.

Of the Entire Blood.

1. THE blood of man, and that of the bullock which much refembles it, and which has been moft frequently fubjected to chemical analyfis, as it is procured with great facility, is a liquid of a beautiful purple-red colour, of a confiftence a little thick, gluey and vifcous, foft and, as it were, faponaceous to the touch, of a particular faint odour, and of a fweetifh and faline tafte. Its temperature is between 29 and 32 degrees centigrade. Phyfiologifts have differed from each other with refpect to the fpecific gravity which they have attributed to it. They have found its relation to the gravity of water as 1053 or 1126 to 1000. It has been faid that, when viewed with the microfcope, it is a compound of red globules fwimming in a tranfparent liquid, and that the red globules are formed of feveral other yellow globules united together; that thefe globules are divided and broken in the fmall veffels, and thus give rife to liquids more and more pale, lefs and lefs coloured, which are found in the orders of veffels more and more attenuated. Thefe globules were defcribed as capable of

of being compreffed, elongated, flattening, and paffing through the animal ftrainers. Modern phyfiologifts have rejected all thefe ideas as chemerical. What is true, fays Haller in the hiftory of thefe globules, is that we actually fee fuch in the blood with the aid of the microfcope; but the yellow ones which are alfo fometimes feen in it are not fmaller than the red, they are not divifions of them, they appear only in debilitated animals; they fwim in a tranfparent and almoft invifible ferum; the red globules have neither been feen to break nor to re-unite, they are not converted into ferum by their pretended divifion, of which in fact (as we fhall fee hereafter) they have neither the characters nor the intimate nature.

6. The entire blood, which we ought to examine before its particular parts, when expofed to a mild temperature and which does not exceed 100 degrees of the centigradel thermometer, diffufes but very little vapour in the air, thickens and coagulates, affumes a brown colour much refembling that of the liver of animals, and gradually dries if we agitate it, fo as to be converted into an almoft black powder, greafy to the touch, and which keeps without alteration in well clofed veffels; in the air it becomes a little moift and covered with an efflorefcence of carbonate of foda. The coagulum of the blood dried in the air becomes fenfibly attractable by the magnet; heated more violently in a crucible, it foftens, becomes as it were oily, melts,

melts, ſwells, inflames and is reduced into coal, after having exhaled a very fetid ſmell. What is diſengaged during this ſtrong and decompoſing action of the open fire preſents a ſeries of products which I have carefully deſcribed; firſt, ammoniacal water; ſecondly, a white and very pungent vapour of carbonate of ammonia, and ſoon a yellowiſh thick ſmoke very fetid, which is manifeſtly oily and inflammable; afterwards Pruſſic acid recognizable by its ſmell of bitter almonds; then phoſphoric acid, announced by ſome flames emitted from the coally and red-hot matter; finally, carbonate of ſoda. There remains in the crucible a mixture of oxide of iron of a blackiſh or brown-black colour, granulated and cryſtallized; of carbon combined with a little iron, and almoſt in the ſtate of carburet of this metal; finally, of phoſphate of lime and muriate of ſoda. We ſee that in this operation the conſtituent principles of the blood are ſeparated almoſt all into binary compounds, if we except the oil and the Pruſſic acid. It is to be obſerved that when the blood is boiled in a baſin of copper, this liquid diſſolves enough of the metal to yield, on calcining it with alkali, cupreous Pruſſiate, even in abundance.

7. When inſtead of treating the blood by the fire in open veſſels, we diſtil it in cloſe apparatuſſes, with a mild heat, eſpecially with that of the water bath, it affords much water, which has a faint ſmell, and putrefies and becomes fetid when kept; the blood at the ſame time

is found coagulated into a brown ſubſtance and even dried. If we afterwards diſtil it in a retort, by a well managed fire till the bottom of the retort of porcelain, in which this diſtillation ought to be performed, is red-hot, we obtain fetid water charged with carbonate and zoonate of ammonia, beſides an ammoniacal ſoap which gives it a red-brown colour; an oil, at firſt red and light, afterwards brown, blackiſh, thick and almoſt concrete, very fetid, and which, before it condenſes, fills the receivers with a thick white vapour of cryſtallized carbonate of ammonia; and laſtly, carbonated and ſulphurated hidrogen gaſes. There remains in the retort a ſpongy coal, of a brilliant and as it were metallic appearance, adhering very ſtrongly to the veſſel, very difficult to be incinerated, in which are found by analyſis, beſides the carbon united with a little iron, phoſphate, muriate, and carbonate of ſoda, phoſphate of iron and phoſphate of lime. Though this diſtillation by a naked and violent fire, the only means of analyſing the blood that was formerly poſſeſſed, does not afford the real principles of the blood as was formerly believed, it correſponds with what has already been indicated in the hiſtory of the general characters of animal ſubſtances, and like the treatment by the open fire, it ſhows us what are in general the primitive principles of the blood.

6. Blood, expoſed to the air, after it has been drawn out of its veſſels, fixes or concretes

more

more or lefs fpeedily; it forms, either an almoft folid mafs, red without and black within, or a fubftance as it were gelatinous, tremulous, refembling currant-jelly, according to the age and the ftrength of the individuals from whom it is taken. It is this fpontaneous coagulation which caufed the ancients to adopt the notion of its plaftic power, and to confider the blood as a kind of liquid flefh. Some hours after this fpontaneous concretion into a fingle homogeneous mafs, the blood fhrinks, condenfes, and there feparates from it a liquid of a greenifh white colour, which is called the ferum of the blood. Though this double effect takes place in clofe veffels as well as in the air, the latter favours its production; its mere contact converts the black colour of the coagulum into a brilliant red; foon, and efpecially when the atmofphere exceeds twelve degrees or the temperate heat, the blood foftens, melts, diffolves, exhales a fmell, at firft faint, afterwards fetid, and at laft is completely decompofed by putrefying. The moifture of the atmofphere accelerates this putrefaction, where s great drynefs combined with a high elevation of temperature in the air, dries this liquid and thickens it, inftead of giving rife to the feptic decompofition like the preceding; the contact of oxigen gas renders the colour of the blood brilliant; azotic and hidrogen gas, on the contrary render it brown or violet; fulphurated hidrogen gas blackens it.

 9. The

9. The blood is entirely foluble in water when it is perfectly liquid; when it is coagulated the water diffolves only its red part and leaves the fibrous, folid and white part of the coagulum infulated: this is the means which is put in practice in order to feparate thefe two fubftances, and form the commencement of an analyfis of the blood both immediate and fimple. If we throw blood into water heated above 45 degrees of the centigrade thermometer, this liquid prefents a number of floating pellicles or membranes; we fee this effect in blood-letting at the foot. Above the temperature here indicated in the water into which it is thrown, the blood is entirely coagulated into brown flakes which condenfe and fhrink together. Long continued maceration of the blood in water favours its putrid decompofition, the colouring matter is precipitated and becomes darker, and the folid fubftance of the coagulum at laft affumes the character of adipocerous fat. Sometimes two parts of water and one part of blood having been coagulated by fire, the liquor feparated from the coagulum, evaporated flowly, yields a bilious extract: it was in this manner that I demonftrated the prefence of bile in the blood in 1790.

10. The acids when mixed with fluid blood coagulate and decompofe it, rendering its colour darker, and more or lefs brown when they are concentrated. The concentrated fulphuric acid renders it very brown and reduces it to coal. The nitric acid, whilft it coagulates it, difengages

gages from it much azotic gas, and converts its ſubſtance into carbonic acid, oxalic acid, and fat matter; the muriatic coagulates it without ſenſibly altering its colour; the oxigenated muriatic acid turns it black like ink. The vegetable acids only thicken it; the acetic acid is the only one of them which effects its coagulation. The cauſtic alkalis, on the contrary, liquefy and diſſolve the blood even when coagulated by the acids; if we mix them with blood recently drawn and which has not yet coagulated, they prevent its coagulation. It has already been ſeen how the alkalis, heated ſtrongly with this liquid, become in part ſaturated with Pruſſic acid.

11. Many ſalts have been mixed with the blood, and their effect has in general been found to correſpond by the antiſeptic property and the ſoftening or liquefaction which they effect, as well as by the obſtacle which they oppoſe to its coagulation. At one time this effect of the ſalts and of the ſaline ſolutions upon the blood was conſidered as an indication of their medicinal virtue; but this notion was ſoon diſcovered to be a real error, dangerous to the art of healing. The earthy ſalts in general are decompoſed by the blood by means of the ſoda which it contains.

The metallic oxides have no ſenſible action upon the blood, except thoſe which by eaſily yielding their oxigen coagulate it. Almoſt all the metallic ſolutions precipitate and coagulate the blood;

blood; they act especially upon its albuminous part; it is almost superfluous here to add that these two classes of bodies, the alkaline and the metallic salts, preserve the blood and defend it against putrefaction.

12. Most of the immediate materials of vegetables, and even of the entire plants, produce this latter effect upon the blood and act upon it as antiputrescent; it is especially in sugar, the volatile oils, camphor the resins and the balsams, that we find this property. The solutions of gum and of starch coagulate it.

Tannin precipitates the blood abundantly; gallin and the pure gallic acid blacken it and form in it an atramentous deposition, which without any other experiment is sufficient to indicate the presence of iron in it. We may obtain this precipitate by diluting the blood with much water. At the same time the astringent property of the gallic acid and of the extract which accompanies it in the gall-nut, thickens, condenses and even hardens the solid matter of the blood; the same effect is observed in all the astringent vegetable substances, particularly in Peruvian bark, Simarouba, the peel of the pomgranate, sumac, the outer shell of the wallnut, tea, &c.

Alcohol, poured upon the blood, also effects its coagulation, but it precipitates it only in small flakes, which water separates and dilutes so as almost to dissolve them.

13. The

13. The blood, like all the other particular animal matters, has its mode and peculiar phenomena of putrefaction. Its colour grows darker and brown, it loſes its conſiſtence, its odour becomes inſufferably fetid; there are ſeparated from it a great number of membranous flakes, brown pellicles which gradually grow blacker; a conſiderable quantity of ammonia and carbonic acid gas is diſengaged from it. It requires a very long time before it entirely loſes its form, and characters of blood, before it becomes a ſolid, thick extractiform matter, and eſpecially before it is reduced to a ſpecies of mould. There are then found in it nearly the ſame materials as in the coal which remains after its diſtillation or combuſtion, except that this reſiduum retains a greaſy or unctuous feel, which announces in its alteration a well-marked production of fat matter.

SECTION III.

Of the Separation and Claſſification of the immediate Materials of the Blood.

14. THOUGH all the chemical characters of the entire blood are not without intereſt, they are however not ſo well marked or ſo important as thoſe which belong to its immediate elements, to the different materials which ſeparate ſpontaneouſly

neouſly from it. It is known that this liquid, when left to itſelf as it iſſues out of the veins or the arteries of the living animal, preſents, whilſt it is hot and fluid, an odorous exhalation which has been conſidered as one of its principles; that it ſoon coagulates or concretes into a tremulous gelatiniform maſs, which condenſes, ſhrinks, gradually approaches in its parts, and expreſſes from itſelf a liquid of a yellowiſh white colour and tranſparent; that it then reſembles a kind of curd, a floating red cake, which has been called *cruor*, *clot*, or *inſula rubra*, that this formation does not take place in the ſame manner when the blood has been violently agitated; that by this agitation, which is frequently practiſed in the ſhambles, there is ſeparated from the blood a remarkable quantity of fibrous matter, ſolid, whitiſh, and ropy, as it were, which attaches itſelf to the ſtick which is employed to ſtir it; that when the ſerum or the white part has been ſeparated from the coagulum, this, waſhed with water thrown in a ſtream upon its ſurface, is ſeparated into two matters, the one of a red-colour, diſſolved in the water with which it has been waſhed; this is the colouring matter of the blood; the other, ſolid, white, filamentous, which is called fibre, or fibrine. Thus there are five matters to be examined in particular; namely, the odorous exhalation, the ſerum, the coagulum, the colouring matter and the fibrous ſubſtance. I ſhall firſt remark that theſe immediate materials of the blood, when

once

once ſeparated from each other, or even two of them, the coagulum and the ſerum, inſulated ſpontaneouſly, cannot again be united, or combined ſo as again to form blood, and that when once the connection is broken between them by their ſeparation from the living body and the ceſſation of the vital motion, their primitive compoſition can no more be made to re-appear.

SECTION IV.

Of the Odorous Exhalation of the Blood.

15. I DISTINGUISH amongſt the principles belonging to the blood the odorous exhalation; in order to conform to the opinion of the moſt celebrated phyſiologiſts who have conſidered it as one of the moſt important elements of this liquid, and who have attributed to it very powerful effects in the animal economy. Some modern philoſophers have thought that this principle was a particular gas, and it is according to this idea that Citizens Deyeux and Parmentier have made experiments upon this exhalation in their new analyſis of the blood. It reſults from their experiments that this principle cannot be obtained inſulated in the form of gas, that when it was condenſed in a bottle of which the blood, which had been put in quite hot, filled one part, and of which the portion full

full of air received this odorous body: this air did not extinguish the tapers that were immersed in it; that it did not precipitate lime water; that it was however sufficiently strongly impregnated with the smell of blood to communicate it to water by agitation, to diffuse after some time a fetid smell, to extinguish these lighted tapers, without however containing ammonia; that it was then a little less pure by the test of the eudiometer; that the odorous water extracted from the blood by distillation on the water bath, and which yielded nothing to the re-agents, putrefied, deposited flakes, and turned the syrup of violets green; that when it was heated in this state it afforded a sediment that burned upon the coals, with the smell of the retort. Blood, distilled with alcohol presented to them, in its volatile product, the very distinguishable odour which it emits when it has been poured into water; yet this odorous alcohol showed no effect upon the re-agents. The chemists whom I have quoted thought themselves authorized to conclude from these experiments, that the aroma of the blood is the most alterable principle, and that which first changes the state of this liquid by escaping in the volatile form. In the phenomena that have been indicated I can see only a small portion of the entire matter of the blood raised in vapour with the water, and I find no relation between the experiments relative to this vapour and the uses that have been attributed to it. It has

been

been erroneoufly believed that the froth formed by the blood, fpouting out and falling from an eminence, was a proof of this gas: it is only air confined by the vifcidity of this liquid.

16 Though I do not admit a particular principle of the odour of the blood; it is neverthelefs of importance to know that this odour is one of the moft marked characters, one of the moft ftriking differences which are found in this liquid, confidered under different circumftances. The odour of the blood is very feeble in infants and in females; it becomes very ftrong at the age of puberty, as foon as the feminal fluid is formed in abundance and collected in its refervoirs; it has then fomething ftrong, acrid and even fetid. The blood of eunuchs is deprived of it, as well as that of old men; accordingly fome phyfiologifts have believed that the fmell of the blood and of the flefh; to which it communicates itfelf, is owing to the fpermatic fluid volatillized, diffufed in the cellular texture of the body, and penetrating into all its regions. Bordeu has ingenioufly treated this remarkable fubject as one of the fymptoms of the fpermatic cachexy, in his medicinal analyfis of the blood.

Section V.

Of the Serum of the Blood.

17. THE name of ferum, water of the blood, and the improper one of lymph, are given to the liquid which feparates from the coagulated blood when it has not been agitated; it is the thinneft and the lighteft liquid contained between the interftices of the coagulum, and expreffed out of its cavities by the approximation and attraction of the molecules of the cruor. The ferum is of a greenifh yellow colour, of a faline and infipid tafte, of a confiftence fufficiently vifcid to glue the fkin flightly, when rubbed between the fingers. Its proportion is very variable and cannot be fixed; however, feveral phyfiologifts have attempted to determine its quantity. Hamberger fuppofed it to conftitute a third of the weight of the blood; Schwenke believed it to conftitute two thirds; Drelincourt and Boyle admitted it to be one half; Quefnay three quarters; Vieuffens gave for the red part 0,62, and for the ferum 0,38; Homberg indicated five parts for the ferum, and three for the red matter. According to Robinfon, it is much more abundant in young animals; the cruor or the red part augments with age, and a period arrives in which the

2 proportion

proportion of the ferum defcends to one third of the red fubftance. It is alfo faid that the blood contains more ferum after meals, and that when the individual is fafting it has much more folid matter. Lower and Haller attributed this effect to the chyle poured in by digeftion. Mufchenbroeck, Martyne, Schwenke, Jurin, indicate the fpecific weight of the ferum compared with that of water as 1027 to 1000.

18. The ferum expofed to the fire coagulates or hardens, and becomes opaque like white of egg. This property is one of the characters by which it is eminently diftinguifhed; it is attributed to a particular matter eafily recognizable by that circumftance, and which is called *albumen*, becaufe it is the fame which exifts in the white egg called *albumen*. When it is gently heated in this ftate of coction or coagulation, the coagulated and folid fubftance becomes hard, brittle, and femi-tranfparent like horn. Heated by fire in the retort, it affords ammonia, carbonate of ammonia, fetid oil, fulphurated hidrogen gas, and a coal in which are found muriate, phofphate, and carbonate of foda. The ferous liquor of the blood is alfo capable of turning the colour of violets green, which is likewife a property which it has in common with the frefheft white of egg. According to thefe experiments, however fimple they may be, the ferum of the blood is confidered as a combination of an albuminous matter with foda; a combination in which the alkali

alkali united with the albumen, preferves its properties as it does in foap.

19. The ferum turns the fyrup of violets green, and the tincture of curcuma brown; it conftantly exhibits the alkaline properties; expofed to the fire, it becomes concrete at the temperature of feventy-five degrees of the centigradel thermometer. This phenomenon, which was firft obferved by Harvey, the immortal author of the difcovery of the circulation of the blood, is one of the moft important which this animal fubftance prefents: every one knows it in the white of egg; but it differs fenfibly in the ferum, as this liquid, being not fo thick as white of egg, neither acquires the fame folidity, nor the fame opaque whitenefs in its concretion. Though it forms a mafs, it is always tremulous; it is found filled with bubbles, and manifeftly formed of two different fubftances when it has cooled after its coagulation; its colour is a pearl-grey, it retains a femi-tranfparency; there is obferved in it a fofter portion, lefs opaque, frequently interpofed between the particles and in the middle of the moft opaque grey mafs, fometimes collected at its furface, efpecially when it has been coagulated flowly and by a well-managed fire. When this portion does not fhow itfelf in this manner, which is the cafe when the ferum is too liquid and too aqueous, the part which does not become fixed, when evaporated and left to cool, concretes into a real

real jelly. The portion which, by the action of the fire, is congealed, and becomes opaque and insoluble, is called albumen, from its analogy with the white of egg; the more transparent matter which becomes fixed especially by cooling, and which is soluble in water, is termed gelatin. Chemists were unacquainted with its existence in the serum of the blood, till I discovered it to be present in it, in 1790. We shall soon see from whence the coagulation of the serous albumen proceeds: it is necessary here to observe, that its concretion by heat always leaves it viscid, gluey, tenacious, and not brittle, smooth and dry in its fracture, as we see in the white of egg hardened by the action of fire.

20. If we treat the serum of the blood by distillation on the water bath, it affords a very large quantity of water slightly odorous, in every respect similar to that which is obtained from the blood, and like it putrescible. The serum coagulated and dried in this operation is brittle, hard, almost transparent, and of a yellow, orange, or brown colour: when strongly heated and distilled in a retort, it affords water and fetid oil, carbonate of ammonia, partly concrete, and partly dissolved in water, a little Prussiate and zoonate of ammonia, carbonated and sulphurated hidrogen gas, and carbonic acid gas. There remains a very voluminous light coal, difficult to be incinerated, which contains, with the carbon, muriates of soda and of potash,

aſh, phoſphate of lime, and carbonate of ſoda. No metallic oxides are found in it. When the coagulated ſerum is ſlowly heated in a retort, ſulphur is ſometimes ſeparated from it, which Citizen Deyeux has alſo obtained from white of egg. A plate of ſilver immerſed in it becomes black, whilſt it is made to coagulate by the action of fire.

21. When expoſed to the air, the ſerum of the blood abſorbs oxigen from it, and exhales carbon into it, whereby a part of the atmoſpheric oxigen gas is converted into carbonic acid gas; in proportion as this liquid abſorbs the atmoſpheric oxigen, it becomes more concreſcible, more capable of being rendered ſolid by the action of the fire; it frequently becomes turbid, and depoſits flakes already ſpontaneouſly concreted. It is for the ſame reaſon that white of egg which has been kept expoſed to the air boils quicker than that which is freſh, that the ſerum of the blood of animals which reſpire is more concreſcible than that of animals which reſpire little: I have thence concluded that the concreſcibility, the plaſtic nature of this humor, proceed from the fixation or the intimate combination of oxigen. Of this we ſhall ſoon ſee other proofs. To this property of abſorbing air, the ſerum owes that of frothing by agitation which it poſſeſſes. Long expoſure to the air favours the ſpontaneous decompoſition of this humor, and accelerates its putrefaction; it then exhales a very fetid ſmell, acquires a brown

a brown colour, becomes ammoniacal, and at laſt leaves a kind of dark-coloured reſidue, which remains for a long time fetid, preceded by a ſoft or entirely melted putrilage, which exhales a great ſtench. The ſepticity of this liquor proceeds ſo rapidly, that Bucquet could not determine whether it paſſed into the acid ſtate before it acquired the ammoniacal character. It is preſerved from putrefaction by all the means indicated in one of the preceding articles.

22. The ſerum of the blood unites with water eaſily, and in all proportions. The aërated water renders it ſlightly turbid, and a ſmall portion of it concrete. Boiled water does not produce the ſame effect, but remains tranſparent. When we diſſolve ſerum in ten or twelve parts of water, the liquor which reſults from it reſembles milk, according to the obſervation of Bucquet: it is white and opaque; it becomes rarefied, and riſes over the fire like that liquid; it yields by evaporation membraniform pellicles; it is coagulable by the acids, &c. &c. The conſiſtent and viſcous ſerum has the property of rendering two or three parts of water ſolid; for notwithſtanding this addition, it is rendered concrete by heat, and the water does not ſeparate from it, on account of the adheſion which it contracts with it. When this humour is diluted with five or ſix parts of water, and heated to ebullition ſo as to render the whole of the albuminous part concrete, the liquid that

is ſeparated from it, when properly evaporated, affords afterwards by cooling, a jelly which becomes fixed. It was in this manner that I diſcovered the gelatin in the ſerum of the blood.

23. The metallic oxides do not unite with the ſerum in general; but thoſe which ſuffer their oxigen to be eaſily diſengaged from them, and which adhere but feebly with it, ſuch particularly as the red oxide of mercury triturated for ſome time with the ſerum, paſs again into the metallic ſtate, or approach to it more or leſs; at the ſame time the ſerous albumen becomes thick, opaque, and more or leſs coagulated. This experiment, which I deſcribed in 1790, proves that oxigen favours the concretion of the albumen, and that, as I have already announced, No. 18, the plaſtic property proceeds from the fixation of this principle; ſo that the concreted albumen is a real oxide. When the metallic oxides are highly oxigenated, and adhere very little with the oxigen, their action goes ſo far as to burn and reduce the ſerum to coal. By this circumſtance is explained the catheretic or even cauſtic effect of the metallic poiſons. It is however to be remarked, that this effect of the oxides of mercury, of their diſoxidation by the ſerous albumen, has a boundary, that it extends only ſo far as to cauſe them to paſs into the ſtate of black oxide, and that in this manner we may conceive why running mercury triturated with ſerum is extinguiſhed or reduced to the ſtate of

 black

black oxide. In these two experiments compared with each other, we see a new proof of the different attraction of different portions of oxigen for the same metal. The first portion is taken by the mercury from the albumen, and the second by the albumen from the oxide of mercury.

24. All the acids coagulate the serum, separate from it the albumen in flakes more or less dense, and of a greyish-white colour, the more solid in proportion as the acids are more concentrated. All of them, after having produced this coagulation, remain in the super-natant liquor, in part saturated with soda, which they have taken from the serum: some chemists have believed, on account of this effect, that the soda was combined with the albumen as it were in a kind of soap, and that it was this that rendered it soluble in water. Rouelle the younger considered it, however, as being almost entirely insulated. Bucquet, on the contrary, maintained that it was intimately combined with it, and that even the acids took away only a part of the soda of the serum; in proof of which he adduced that the coagulum formed in this liquor by acid in great excess, contained still carbonate of soda after its combustion and incineration: this fact however requires to be confirmed. The coagulation of the serum by the acids is prevented by mixing with it, before it is added to the latter, a certain quantity of the solution of an alkaline carbonate; the

effervefcence which the acid that has been added produces carrying off the caloric in order to reduce the carbonic acid to the ftate of gas, no longer permits the mixture to become heated, and confequently guards the albumen againft the coagulation which it experiences without this addition.

25. Befides this general effect of the acids upon the ferum, each of them has fome peculiar to itfelf. The concentrated fulphuric acid turns it brown, and reduces it to coal; that which is diluted with water only coagulates and preferves it. The nitric difengages from this humour coagulated by fire, azotic gas, carbonic acid gas, Pruffic acid gas, and converts the reft into oxalic acid and fat. The fuming muriatic acid communicates a violet colour to the ferum, or coagulates it; by a long contact it becomes faturated with ammonia by decompofing this fubftance. All the other acids precipitate, coagulate, and preferve the ferum; ammonia eafily diffolves the albuminous coagulum formed in the ferum by their action.

26. All the earthy and alkaline bafes have actions more or lefs marked upon the ferum of the blood. The folutions of barites, of ftrontian, and of lime, precipitate this liquor; the precipitate is a real infoluble phofphate. The leys of fixed alkalis render the ferum more liquid; with the aid of heat they diffolve its coagulated albumen. The cauftic and dry pot-afh or foda, triturated with this liquor when

thick

thick or boiled, ſuddenly diſengage ammonia from it, and diſſolve a part of the remainder. When theſe alkalis are heated and calcined with coagulated ſerum, the ley which is made of the reſidue of this coagulation, is found to contain Pruſſic acid, and precipitates iron in the blue ſtate. When the ſerum is boiled with an alkaline ley much diluted, and when this liquor is filtrated, the weak acids poured into it diſengage from it a very perceptible ſmell of ſulphurated hidrogen gas: this is one of the proofs which Citizen Deyeux has adduced to prove the preſence of ſulphur in the ſerum of blood, which is beſides manifeſted by other experiments that have already been indicated.

27. Serum combines with moſt of the ſaline ſolutions, without experiencing any alteration from them, except being preſerved and defended againſt putrefaction. It however decompoſes the calcareous ſalts by virtue of the ſoda and phoſphate of ſoda which it contains; the precipitate which it forms in it is a compound of lime and phoſphate of lime. The ſoluble baritic ſalts produce no effect upon it. Thoſe of ſtrontian are decompoſed, and their baſe is precipitated by ſoda. The ſame is the caſe with the ſalts of alumine, of zircon, and of glucine. The ſoda of this liquor ſeparates alſo the ammonia from the ammoniacal ſalts, and this volatile alkali ſeizes the albumen of the ſerum, which it diſſolves, or at leaſt renders more fluid.

28. I have already ſaid, that the metallic oxides thicken and coagulate the albumen; and it is evident that, combined with the acids, they muſt produce this effect in a ſtill more powerful manner, as they are aided by the latter, which themſelves alſo produce it in a very marked manner. When we pour a metallic ſolution into the ſerum of the blood, there is ſuddenly produced in it a thick and coagulated precipitate, formed by the metallic oxide and albumen. But beſides this, the muriates, the phoſphates, and the ſoda which it contains, occaſion another kind of decompoſition in the metallic ſalts: ſo that the precipitate which they form in them is generally compoſed of four ſubſtances, the oxide ſeparated by the ſoda, the oxide united with the albumen, a muriate and a phoſphate of the ſame oxide. Such eſpecially is the effect of the nitric ſolutions of the white metals, of mercury, of lead, and of ſilver; the latter alſo ſhows the ſulphur in it by the black ſtreaks which it forms in it. Theſe precipitates, eſpecially that of mercury aſſume a roſe or fleſh-coloured tinge. The ſerum treated in this manner has become unalterable and imputreſcible. There are ſome metallic ſalts which are capable of uniting with the ſerum without decompoſition: ſuch eſpecially is the phoſphate of iron with exceſs of oxide, which colours it red.

29. Some vegetable matters act in a particular manner upon the ſerum. Alcohol coagulates

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it and precipitates it in small whitish flakes, which easily divide in water and remain so well suspended in it that we might consider it as dissolved. Bucquet had even announced that the coagulum formed by alcohol was entirely soluble in water, and disappeared when a sufficient quantity of this liquid was added. The fixed oils are rendered miscible with water by the serum of blood. The volatile oils, camphor, the resins, the balsams, and the gum-resins, preserve this liquid, and prevent its putrid decomposition. Tannin is of all the immediate materials of vegetables that which has the most remarkable action upon the serum of the blood: it precipitates itself abundantly into a yellow, gold-coloured, ropy, and pitchy substance, insoluble in water, which dries and becomes brittle in the air, which has no longer any kind of alterability, and which resembles leather too much tanned and become dry, hard and brittle, by excessive tanning. The gelatin and the albumen are equally precipitable by tannin, but the first is more easily dried than the second; and though the distinctive characters of these two tanned substances have not yet been determined, it is no less certain that they present reciprocal differences which may hereafter serve to distinguish the one from the other, perhaps even to separate them, and estimate their proportion.

30. All the facts relative to the properties of the serum of the blood prove, that this liquid is a kind

a kind of animal mucilage, compofed of albumen and gelatin in different proportions, diffolved in a variable quantity of water, conftantly combined with pure foda, which is united with the albumen almoft in a faponaceous combination: we alfo find in it muriate of foda, phofphate of foda, ammoniacal phofphate, and phofphate of lime. The latter appear to be not effential to its combination: not only their proportion varies; but they may exift or not exift, be in the number indicated, admit of the abfence of fome of them, or the fimultaneous prefence of a greater number. For example, we may find in it muriate of pot-afh, phofphate of magnefia, or ammoniaco-magnefian phofphate, &c. without the albuminous alkaline and gelatinous matter of the ferum of the blood changing or prefenting properties foreign to thofe which characterize it.

SECTION V.

Of the Coagulum or Cruor.

31. WHEN the blood, after feveral hours coagulation, has afforded all the ferum that can run, and be expreffed from it, the coagulated, half folid, and contracted fubftance which fwims in the middle, is known by the name of

of *coagulatum, placenta, insula.* This mass has been called *cruor* before the means of separating it into the two different matters which constitute it, had been discovered.

It appears that the differences of proportion between the serum and the cruor, that have been admitted by the different authors, are owing to its variable quantity, Wieussens estimated it at 0,62, and gave only 0,38 to the serum; Homberg gave five parts to the latter and three to the cruor; Schwenk reckoned the serum at two-thirds, and the cruor at one-third; Quesnay the serum at three-fourths, and the cruor at one-fourth; Senac the serum at four-fifths, thee cruor at one-fifth; Schwenk admitted it to be only one-eighth. Boerhaave adopted the latter proportion. In general physiologists, according to Haller, think that the cruor increases as the individual advances in years; that the serum predominates in young animals; that those which are vigorous afford more cruor, and that when they are debilitated or badly fed, this matter diminishes in them. Nevertheless it results from this comparison of opinions and facts, that the cruor or the substance of the coagulum is in general less abundant than that of the serum. It is also to be observed that the proportion of this solid or cruoric part of the blood diminishes more the longer we leave the serum to separate, and that it always tends, by shrinking

ſhrinking together, to preſs out a larger portion of the gelatino-albuminous liquid.

The blood coagulates, or aſſumes the concreteſtate in cloſe veſſels as well in open ones, in the heat as well as in the cold; it is therefore, neither the air nor refrigeration which coagulate the blood, but the privation of the vital motion.

This coagulum is formed ſooner or later; its conſiſtence varies from the tremulous ſoftneſs of currant-jelly to the ſolidity of a kind of leather. In youth and in females it is ſofter; in old age its tenacity is very great. When the blood becomes covered with a buffy coat in ſome particular diſpoſitions of the ſubject, or in inflammatory affections, it is obſerved that the coagulated and red part which it covers is leſs ſolid and leſs abundant; which proves that the ſubſtance of this coat, is formed at the expenſe of that which forms the ſolid part of the coagulum. Blood received, as it iſſues out of the vein, into a ſolution of ſalts, nitrate of pot-aſh, or ſulphate of ſoda, does not coagulate.

Its ſurface which is in contact with the air is of a brilliant purple-red, its interior is dark coloured and almoſt black; but this interior part, when expoſed and opened in the air, aſſumes the clear and brilliant tinge of the ſurface. Incloſed in a veſſel full of atmoſpheric air, the coagulum quickly alters it, whilſt it becomes red, and converts the oxigen into car-

bonic

bonic acid. Hidrogen gas and carbonic acid gas give it a violet colour; the firſt of theſe gaſes becomes carbonated.

The coagulum corrupts rapidly and becomes inſupportably fetid. In a hot place, as a ſtove or an oven, it dries without putrefying, and becomes converted into a kind of powder. Thrown into boiling water it acquires more conſiſtence than it naturally has; its colour paſſes into an homogeneous brown; the water becomes turbid, and preſents at its ſurface an abundant ſcum; the acids thicken and harden it, at the ſame time rendering it brown. Alcohol heated upon the coagulum aſſumes a lemon colour and condenſes its texture. The alkalis on the contrary ſoften and diſſolve it; they change its colour leſs than the acids.

32. The coagulum being tied in a bag of linen, and waſhed under a ſtream of water till this ceaſes to be coloured by it, when the linen is ſlightly compreſſed between the fingers, ſeparates into two diſtinct ſubſtances, preciſely in the ſame manner as we have ſeen the paſte of the flour of wheat ſeparated into two ſubſtances by the ſame operation. We may alſo effect this ſeparation in the hand by uſing only a very ſmall ſtream of water, or upon a very cloſe hair ſeive always with the ſame precaution of employing but very little water, and receiving it gently upon the ſurface of the coagulum. Theſe two matters are, 1. the red colouring part which diſſolves in the water and runs off

in

in the waſhing; 2. a white ſolid ſubſtance, filamentous and flaky, which remains in the bag, in the hand or upon the ſieve, and which is much leſs voluminous, and at the ſame time much more denſe than the coagulum. There is this very perceptible difference between the product of this operation and that of the waſhing of the paſte of flour, that the wheat yields ſtarch in powder; which renders the water turbid and milky; whereas the coagulum does not render water opaque nor leave any fecula precipitated, but permits the red colour to diſſolve in the liquid, which paſſes off tranſparent. By purſuing this compariſon, we ſee alſo that the white concrete ſubſtance obtained as reſiduum of this waſhing correſponds with the glutinous part of wheat, and that the coloured liquor of the cruor that has been waſhed repreſents at the ſame time the amilaceous fecula and the mucoſo-ſaccharine matter of the flour.

SECTION. VI.

Of the Colouring Part.

33. THE water which is employed for waſhing the coagulum of the blood, takes from it the whole of its colour and acquires a more or leſs brilliant-purple tinge. This is what is termed the colouring part of the blood. It appears to be

be nothing more than a dilute ſolution of albumen and gelatin, with which a ſmall quantity of iron, in the porportion of a few thouſandths is mixed. It is thus that Bucquet has deſcribed it, comparing it with the ſerum, from which it appears to differ only by the metal thus indicated. This difinition could not enable us to underſtand the adheſion of this ferrugineous ſerum with the coagulum, and the ſeparation of the white ſerum which is effected, except as a ſimple expreſſion of the thinneſt and moſt fluid part of the liquid, and as the more intimate attraction of the portion condenſed by the oxide of iron for the concrete and fibrous part of the coagulum. But ſuch a general or ſuperficial notion is not ſufficient; we muſt ſtudy with greater attention the properties of the ſanguine colouring liquor, and inveſtigate thoſe which particularly characterize it.

34. The aqueous ley of the coagulum, which is tranſparent at the moment when it has juſt been obtained, becomes turbid and depoſits membranous flakes at the end of ſome time; it turns the ſyrup of violets green. Even when heated on the water-bath, it forms a brown coagulum, which ſwims in a turbid water. This coagulum ſeparated from the liquid portion by filtration, preſſed and dried, becomes brittle, pulverulent, inſipid and inodorous. We ſee it in what is called the *ſcum of the pot*, when the entire fleſh is boiled in water. Alcohol takes from

from it but very little, and aſſumes a red colour. The acids blacken and alter it, they alſo form it and ſeparate it from the water by coagulating it. The pure alkalis diſſolve it, and it is precipitated from them by the acids. The coloured coagulum affords in diſtillation the ſame product as that of the white ſerum, and it preſents ſo many analogous properties that it is impoſſible not to confound it with the albumen of the former liquor. One difference however preſents itſelf when we compare their coat, ſince that of the red ſerum contains iron, as ſhall be ſhown.

35. When we ſeparate, by the action of fire, the ferrugineous albumen from the large quantity of water in which it is diſſolved, whatever temperature may be employed, and whatever time we may beſtow upon this ſeparation, we can never obtain it entire; becauſe the part which is coagulated fixes about a fifth of water in which it was diſſolved; the ſupernatant liquor alſo retains a portion of albumen, and there is eſtabliſhed an equilibrium of combination, a mutual partition between theſe two bodies. Alſo by evaporating the liquor that is not thickened, after having ſeparated it by filtration from the ſolid and coagulated matter which it contained, it preſents at its ſurface towards the end of the evaporation, a brown pellicle, which breaks and is precipitated into coloured flakes. When it is denſe and clear, alcohol heated upon it diſſolves a part of it, aſſuming a deep brown colour,

colour, and leaves by evaporation a refiduum of animal matter, foluble in water, frothing by agitation, like a folution of foap, ftrongly turning the colour of violets green, and precipitated by the acids. Thefe laft properties indicate that the albumen combined with foda actually refembles a faponaceous combination.

36. When Menghini difcovered the prefence of iron in the blood; when Rouelle confirmed it by new experiments; neither of thefe chemifts determined in what ftate this metal was contained in it. Citizens Deyeux and Parmentier believed it to be combined with foda, and in a ftate nearly refembling that of the ferruginous alkaline tincture. The following is the manner in which Citizen Vauquelin and myfelf found that the iron was united in it with phofphoric acid, as Citizen Sage had announced a long time before, but without proving it, and as Mr. Grew, Profeffor at Halle, had afferted more pofitively, though he did not indicate by what means we might be convinced of it. When the red part of the water in which the coagulated blood has been wafhed is burned in a crucible, we obtain a refiduum of a dark red colour, forms 0,0045 of the blood that has been employed, but which, when diffolved in the muriatic acid, amounts only to between 0,0017 and 0,0006 when feparated from what is foreign to it, or thofe faline matters which do not contain iron, by the following proceffes. It is digefted in very weak nitric acid, which diffolves

diffolves a part of it, and leaves another more red than before. Ammonia poured into this folution affords a white precipitate, which when treated whilft ftill wet by cauftic pot-afh, lofes part of its weight, and affumes a very dark-red colour. Lime water, poured into this ley of pot-afh, forms a white precipitate of phofphate of lime. We may employ muriatic acid for diffolving the phofphate of lime, which remains after the combuftion of the coagulated red ferum.

37. In order that we may be the better able to conceive the nature and the ftate of this phofphate of iron, and underftand how it can be diffolved in the blood along with foda, it muft be obferved, that there are two phofphates of this metal, the one white-grey, frequently of a pearly brilliancy, infoluble in water, foluble in the acids, and the other red, more or lefs brown, and lefs foluble in the acids; this is phofphate with excefs of oxide of iron, and the other is faturated with its acid. The white phofphate of iron is decompofed only in a partial manner by the cauftic alkalis, which take from it only a part of its acid, and leave the falt with an excefs of this bafe. It is in this ftate of phofphate fuperfaturated with iron, a ftate maintained by the prefence of the foda, that this metal is diffolved in the blood, and in particular in its ferum. The blood of all animals, when it is red, is coloured by the phofphate of iron.

38. We

38. We have found in our experiments relative to the colouration of the blood, that the ſuper-oxigenated phoſphate of iron has an exceſs of its baſe, that this phoſphate diſſolves very well, and by the ſlighteſt agitation or trituration, in raw white of egg, and in the ſerum of the blood: it is not even neceſſary to employ the aid of heat in order to effect this ſolution, ſince it takes place in the cold by mere motion, preſenting immediately a very ſtrong red colour, which reſembles that of the blood. A little pure fixed alkali accelerates this ſolution, and renders its colour more perfect and lively. Thus the phoſphate of iron, the quantity of which, though very ſmall, is ſufficient to colour the blood, exiſts in it in the ſtate of ſuper-oxidation, and of exceſs of metal; it is diſſolved in its albumen, and brightened by the ſoda contained in it. Perhaps the phoſphate of ſoda exiſting in the ſerum has no other origin than the partial decompoſition of the phoſphate of iron by the ſoda.

39. Amongſt the properties which diſtinguiſh the red ſerum, or the colouring part of the blood, we muſt particularly mention its change of colour by the contact of the air; the luſtre imparted to it by the oxigen gas, or the aërated water employed for waſhing the coagulum; the violet brown, which it contracts from carbonic acid gas, and eſpecially from carbonated hidrogen gas; the influence which it has upon the alteration of the air, the formation of carbonic acid which it excites, and the abſorption of oxigen which it produces. If theſe phenomena

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are more energetic and more prompt in the red ferum than in the white, and if the difference which exifts between thefe two fpecies of ferum entirely depends upon the prefence of the fuper-oxigenated phofphate of iron which the firft contains, it is evident that this metallic falt is the caufe of the colouration of the blood, and of the luftre which this colour acquires by the contact of the atmòfphere, as alfo of the changes which this red ferum, at the fame time, occafions in the air in which it is immerfed.

40. Citizen Deyeux believes, that the colouring matter of the blood, befides albumen, gelatin, the phofphate of iron, and the falts, which analyfis has difcovered in it, contains a particular fubftance, to which he attributes feveral of its characters, and efpecially the homogeneous concretion of the entire blood in the preparation of puddings; on which account he calls this fubftance *matière tomelleufe*. It is fince his inveftigations concerning the blood that he appears to have directed his attention to this matter, as he had faid nothing at all of it in the Journal de Phyfique, in which his firft analyfis is inferted. He has diftinguifhed the tomelline; for it is ufeful to give to his name a termination fimilar to that of feveral other animal fubftances, with which it appears to have much analogy in its form, its confiftence, as well as in feveral properties which have appeared to him to be different from thofe which are known in the albumen, the gelatin, and the fibrine.

But

But he has himſelf given the firſt notions relative to this particular matter, only as mere ideas, which deſerve to be verified and purſued, in order to receive from experience, that confirmation which alone can prove the exiſtence of this new body.

41. I muſt not omit, amongſt the properties of the colouring matter, or of the red ſerum of the blood, that of diſſolving copper, which preſented itſelf to Citizen Vauquelin with ſo remarkable an energy as to induce him at firſt to believe that the blood contained this poiſonous metal amongſt its principles. The following is the manner in which this diſcovery preſented itſelf to him. Having boiled the water in which the blood had been waſhed in a very clean copper kettle, in order to coagulate the albumen, and having filtrated the liquor in order to collect ſeparately the coagulated matter, with the intention of carefully examining its colouring part, he burned this concrete ſubſtance in an earthen crucible, and diſſolved its ferruginеous reſiduum in the muriatic acid. When he attempted to precipitate the ſolution by ammonia, he was much ſurprized to ſee the liquor, which contained an exceſs of this alkali, aſſume a beautiful blue colour. The liquor was ſaturated and diſcoloured by the muriatic acid, and a plate of iron that was immerſed in it became covered with a brilliant ſtratum of copper, the quantity of which was ſufficiently conſiderable after two days to be able to be ſeparated and

 detached

detached from the iron. The water from which the coloured albumen had been feparated by coagulation, contained no copper; whence Citizen Vauquelin concluded that the folution of the copper was owing to the albumen; that it was effected at the moment of the feparation of the albumen by the heat; that the copper combined and precipitated itfelf with the concrete albuminous matter. In fact, this more oxigenated part of the blood exerts a very marked attraction upon the metallic oxides, combines with them with confiderable force, and feparates them, as we have feen, from the acids. According to this fact, it is an important caution, that blood prepared for food fhould not be boiled in copper veffels. It is alfo to be obferved, that in precipitating an alkaline ley of blood by the acids, we obtain more Pruffiate of copper than even Pruffiate of iron. The firft is recognized by its purple-red colour when it is moift, and its dark-red colour when dry.

42. The red ferum of the blood, or the colouring part of this liquid, obtained by wafhing the coagulum, after the feparation of the ferum, or of the white ferous part, is therefore compofed of a large quantity of water, of albuminous and gelatinous matter, of fuper-oxided phofphate of iron, of foda, and of fome faline fubftances. The latter, and particularly the phofphates and muriates, are much lefs abundant in it in their proportion with the albumen than

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in the ſerum properly ſo called, ſince this, which has flowed ſpontaneouſly out of the coagulum, and which was its moſt fluid part, muſt have carried off with it all the more ſoluble parts that were contained in it, and the ſalts hold the firſt rank in this order. It is very evident that we do not ſpeak here of the proportion of the materials of the red ſerum to the water which diſſolves them, as we may conſider it in the white ſerum, becauſe the quantity of the water added, depends entirely upon the will of the perſon who operates, and the proceſs which he employs. The ſuper-oxigenated phoſphate of iron, or the red phoſphate of iron, which colours this ſerum, ſeparated from the coagulum, is diſſolved in it by the albumen, and is precipitated with it when the fire coagulates and ſeparates it from the water; this albumen retains even a part of its diſſolvent activity, ſince beſides the ferruginеous ſalt which it naturally contains, it re-acts ſo quickly and ſo powerfully upon the copper, and undoubtedly upon other metals. We may underſtand the ſimultaneous preſence of phoſphate of iron, and of ſoda in the blood, when we know the fixed alkali decompoſes this metallic ſalt only in part, and reduces it, like the Pruſſiate of iron, only to the ſtate of phoſphate with exceſs of iron, or red phoſphate, and that it is in this ſtate in the blood; we comprehend it ſtill better when we recollect that iron, which is oxided in a ſolution of phoſphate of ſoda, decompoſes a part of this ſalt, and paſſes

into

into the ſtate of ſuper-oxigenated phoſphate of iron. Perhaps, it is alſo in this manner, that this ferrugineous ſalt is formed in the blood, and that the ſeparation of the ſoda is effected.

SECTION VII.

Of the fibrous Part of the Blood, or of the Fibrine.

43. WHEN the coagulum, tied in the linen bag, has been well waſhed, there remains a white matter in hard filaments, interlaced with one another in a texture reſembling felt, which has been called *fibrous matter*, and which is denominated *fibrine* in the methodical nomenclature. This ſubſtance ſeparates itſelf from the blood when it is agitated in the ſhambles, and attaches itſelf to the ſticks with which it is ſtirred, in the form of ſmall ſolid faſciæ, twiſted together like intermingled threads, of a roſe-colour, which become white by waſhing. We conſtantly find it ſtill floating in ſmall flakes, or in whiteiſh fibres, in the water into which the blood is received in blood-letting at the foot; ſometimes ſimilar filaments come away with the blood in veneſection at the arm, and it cannot be doubted, that to theſe filaments are to be attributed the pretended worms which have

been ſaid to have ſeen iſſuing out of opened veins.

44. The fibrine when well prepared, drained upon paper without ſize, and dried in a ſtove, thereby loſes two-fifths, or between 0,39 and 0,40 of its weight. The medium quantity of this matter, taken from the blood of ſix different perſons, amounted in our experiments to 0,0028; in the blood of a greater number of perſons compared, the *minimum* of its proportion was 0,0015, and the *maximum* 0,0043. The fibrine is void of taſte, and of ſuch conſiſtence and tenacity in its texture, that animals cannot maſticate it without much difficulty. When it is expoſed ſuddenly to a violent fire, it ſhrinks and moves like parchment. When diſtilled by naked fire, and in a retort, it affords water charged with carbonate of ammonia, a thick, heavy, and very fetid oil, and much concrete ammoniacal carbonate. There is alſo diſengaged from it carbonated hidrogen gas, and carbonic acid gas: it is one of the animal ſubſtances which furniſh the moſt oil and ammonia; accordingly, I have indicated it as a ſubſtance particularly azoted. The coal which it leaves after its diſtillation is compact, heavy, and rather difficult to be incinerated. We find only phoſphate of lime in its aſhes; we extract it and aſcertain it by diſſolving it in the nitric acid, and precipitating it by ammonia. It contains neither ſoluble phoſphate nor iron.

45. The

45. The fibrine putrifies quickly and violently in water; it exhales a fetid ſmell, and is converted into an adipocirous fat ſubſtance; there is alſo diſengaged from it much carbonate of ammonia during its putreſcence. It is not ſoluble in water, and when left for a long time in this liquid in the boiling ſtate, it becomes hard like horn, aſſuming a grey colour. The alkalis, diluted with water, have very little action upon it; it is equally inſoluble in ammonia. The leys of cauſtic fixed alkalis, barites, pot-aſh, ſoda, and ſtrontian, highly concentrated, attack it, however, with the aid of heat; they give it a brown-red colour, diſengage ammonia from it, ſoften it, and at laſt entirely melt it. The reſult is a kind of bitter fluid and viſcous ſoap, which the acids and the metallic ſalts decompoſe.

46. The acids have a much more ſenſible action upon the fibrine. Even the weakeſt diſſolve it. Weak nitric acid diſengages from it in the cold much azotic gas, afterwards with the aid of heat Pruſſic acid gas, and carbonic acid gas, mixed with nitrous gas; there are then formed yellowiſh fatty flakes, and the liquor holds oxalic acid in ſolution. The concentrated ſulphuric acid reduces it to coal, converting it in part into water and acid. The muriatic diſſolves it, and gives it the form of a green jelly. The acetous acid alſo diſſolves it, like the citric, tartarous, and oxalic acids, with the

the aid of a gentle heat. All thefe acid folutions affume, when they are concentrated by evaporation, or otherwife well faturated, and by cooling, the gelatinous form: they then refemble a real jelly. The alkalis precipitate the fibrine from thefe acid folutions in flakes, altered indeed, and which have become foluble in hot water; it would then feem that it has affumed the character of gelatinous texture, and that it has experienced a kind of retrogradation in its compofition.

47. We muft add to thefe properties, which are already very capable of characterizing the fibrine, and diftinguifhing it from the other animal fubftances, that it affords, amongft the products of its diftillation, a remarkable quantity of the zoonic acid, difcovered by Citizen Berthollet, and that it thus exhibits, in the experiments to which it is fubjected, a very animalized matter, very much azoted, efpecially which reprefents almoft the laft term of animalization, or of the animal compofition. It is, perhaps, to an alteration of this fubftance, analogous to what takes place with it in its converfion into zoonic acid, that we have to attribute the acidification obferved by Citizen Chauffier, who afferts, that he has extracted a particular acid from the coagulum treated by alcohol.

48. Notwithftanding the fmall quantity of fibrine contained in the blood, we fhall fee hereafter, that it acts a very important part in the animal organization, and in the life of animals, fince

ſince it depoſits itſelf in their muſcles, the particular texture of which it conſtitutes, and ſince it becomes the ſeat of one of the moſt important and moſt incomprehenſible vital functions, that of irritability, and conſequently the principle of the motion which preſides over all the other functions, from that of the heart, in which the ſupport of life reſides, to that of the ſmalleſt muſcular fibre.

Section VIII.

Of the principal Differences of the Blood.

49. It is not ſufficient to have examined the entire blood, and its different elements, or immediate materials in the moſt general circumſtances, or to have determined its properties, that are in ſome ſort mediate or common. Chemiſtry can proceed ſtill much farther; it ought to embrace a ſtill much greater whole, and apply itſelf to much more extenſive details. It is its buſineſs to appreciate the differences which this vital liquid preſents, according to the places which it occupies in the body, according to the ages and the ſex which modify it, according to the different orders of animals to which it belongs. Though the analytical labours which theſe data require, in order to be obtained, are yet but ſmall

advances,

advances, chemical knowledge has, neverthelefs, already thrown fome light upon thefe confiderations, and it is important to collect thofe lights, as it were, into a focus, in order at leaft to illuminate the entrance of an immenfe courfe, which medicine expects in this refpect from Natural Philofophy, which muft preceed her in his route hitherto fo little frequented.

50. The ancients had fome notions concerning the difference of the blood contained in the two orders of arterial and venous veffels: by admitting in the firft, a fpirit, or an elaftic air, they feemed to have confidered the blood which circulates through them, as rarefied, aërated, and frothy. It is no longer doubted, fince Harvey, that the blood of the arteries is more red, more hot, more rare, and more irritating than that of the veins, and pneumatic chemiftry has fhown, that in fact the arterial liquid owes thefe properties to the oxigen gas which it abforbs in the lungs, and to the lofs which it has there fuffered of a portion of its hidrogen, and of its carbon. In proportion as it circulates, it lofes both its heat, and its oxigen, and its proportions; fo that having become of a brown-red colour, lefs hot, lefs concrefcible, more hidrogenated, and more carbonated in the veins, it is difpofed to become oxigenated, heated, dif-hidrogenated, and decarbonated in the pulmonary veficles; and we fhall fee that refpiration has thefe fimultaneous effects, as its object and its function.

51. To

51. To this difference of the blood in the fyftem of the arteries, and in that of the veins, we muft add that which it acquires in the different regions through which it circulates. It has been believed to be more light, more aërial, more fpirituous in the veffels of the head, and difpofed thereby to form the nervous fluid or the vital fpirit, which as yet is indeed only an hypothefis. It is known, that it is fat and oily, or at leaft very much difpofed to become fo in the abdomen, and efpecially in the fyftem of the vena porta; that it alfo undergoes a change that has not yet been appreciated in the fpleen; that it is very much attenuated, and replete with life and activity in the fpermatic fyftem. There is alfo no doubt, that it has a very particular character in the vicinity of the kidneys, and efpecially where it iffues out of this urinary organ, and in the emulgent veins, though it is not known in what this character confifts. It is no lefs evident, that near to the heart, and before it enters it in order to be fent into the aëriferous apparatus of the lungs, the chyle which it receives, modifies and renovates it by furnifhing to it a pure fource of continual reparation. We cannot miftake the particular difpofition which it has to become folid and converted into fibrous texture, which it affects by being retarded in thofe arteries, almoft always retrograde, which carry it into the mufcular flefh.

52. Mere

52. Mere inſpection is ſufficient to ſhow, that the blood varies according to the age and ſex of the individuals. That of the fœtus differs eſſentially from that of the infant after reſpiration has commenced, becauſe the air has not yet touched or impregnated it. Already the firſt experiments which I have been able to make upon this ſubject, have ſhown me that the blood of the human fœtus which has not yet reſpired, contains inſtead of the fibrous matter, only a ſoftiſh texture, without conſiſtence, and as it were gelatinous; that it is not ſuſceptible of being reddened by the contact of the air, like that of the adult, and that it preſents no phoſphoric ſalts.

Sometime after birth the blood aſſumes a bright colour, a more conſiderable concreſcibility, and it becomes enriched with phoſphates, eſpecially with that of lime, which being furniſhed in conſiderable abundance by the milk of the mother, quickly carries the ſolid matter to its bones.

At the age of puberty the blood is more hot, more highly coloured, more irritating, more odorous, and vivified by the ſpermatic emanation which prevails; moved with force in its ſtrainers, it tends to eſcape from them: and this is the epocha of turgeſcence and of hæmorrhages.

The blood of the ſubject that has become adult, and in the permanent vigour which ſucceeds youth, has more conſiſtence and more fibrous matter.

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In old age, it loſes part of its energy, its heat, and its plaſtic property, but it becomes more diſpoſed to be detained, and to form concretions of ſeveral kinds.

The blood of the female preſerves for a long time the character of the blood of youth; it has been ſuppoſed, that the uterine and the menſtrual blood have ſome particular qualities, a diſtinct ſmell and vapour which act at a diſtance upon flowers and fruits, upon liquors in the the ſtate of fermentation, the colouring matters, &c. When we ſeparate from this opinion what is erroneous and exaggerated in it, it preſents to the impartial obſerver ſomething true, which ought to be aſcertained by exact experiments, inſtead of denying what has not yet been comprehended.

53. The different orders of animals have certainly differences in their blood, proceeding from thoſe of their nouriſhment, of the digeſtive, reſpiratory, &c. organs. The chemical inveſtigations by which theſe differences are to be aſcertained, have hardly been commenced; we have yet only very few general obſervations upon ſome of the properties of the blood, compared in the different orders of animals.

A. That of the mammalia approaches very near in its nature to that of the human ſpecies; like the latter, it contains a white ſerum, a ſerum coloured by ſuper-oxidated phoſphate of iron, fibrine, muriates of ſoda and pot-aſh, phoſphates of ſoda, and of lime and ſoda, the pro-

portions

portions of which vary in each particular animal, as Rouelle the younger has ſhown, by giving a table of the quantities of ſalts which he had extracted from the blood of the horſe, the bullock, the aſs, the calf, the ſheep, the goat, and the hog. This chemiſt was much aſtoniſhed, that the animals which eat vegetable food, and conſequently pot-aſh, conſtantly preſented free ſoda in their blood; however, it is eaſy to conceive, that the pot-aſh ought to decompoſe the muriate of ſoda. He found no phoſphates in it; for the knowledge of theſe we are indebted to my analyſes made ſince 1780.

B. The blood of birds is in general more red and more hot than that of the mammalia, and very quickly becomes fixed or coagulated; its coagulum is gelatinous; it does not ſeparate from the ſerum except with difficulty. Its colour is never ſo brown or ſo dark as that of the blood of men, and of the mammalia. No comparative analyſis has yet been made of it; we know neither the proportions of its parts, nor the ſalts that are contained in it.

C. The blood of the amphibia, and of the fiſhes, is as little known as that of the birds; no chemiſt has yet examined it; we only know, that it is colder, very little ſuperior to the temperature of the air or the water in which theſe animals live, that it is little concreſcible, and that it appears extremely diſpoſed to become oily.

D. As

D. As to the mollufca, the infects, and the worms, it has been believed, that they have a white or little coloured blood, but no experiments have been made in order to afcertain the characteriftic properties of this liquid. However, there exifts in feveral of thefe animals a red blood, analogous in its appearance to that of the preceding. It is needlefs to obferve, that an exact analyfis and comparifon with that of the kinds of blood already, will throw much light upon the functions of thefe beings.

SECTION IX.

Of the Alterations of which the Blood is fufceptible.

54. ONE of the moft important refults which medical philofophy expects from the refearches of chemiftry refpecting the blood, confifts in appreciating the changes and alterations in the different morbid affections; but thefe refearches have fcarcely been as yet commenced. Citizen Deyeux and Parmentier have juft begun to examine the blood in fome difeafes. They have found in general that the albumen is the element the moft altered in this liquid; they have made fome experi-

ments

ments upon the blood of ſubjects attacked with inflammatory diſeaſes, with ſcurvy, and with putrid fever.

55. The blood, which is called *inflammatory*, taken from pleuritic patients, preſented to them a buffy coat which covered its ſurface, a ſoft coagulum, a coagulation as it were partial, filamentous and interrupted in the heated albumen, the impoſſibility of cauſing it to coagulate in boiling water, and the property of giving it a milky colour. The buffy coat appeared to them to be formed of the fibrin altered, ſoftened, melted into a kind of gelatin, ſoluble in the acids; accordingly the blood upon which it is formed preſents a very ſoft coagulum, which ſcarcely affords any fibrin when it is waſhed, or which diſſolves almoſt entirely in water. We ſee that the inflammatory character of the blood conſiſts in melting, or liquefaction of the fibrous part and of the albuminous matter, inſtead of the thickneſs and coagulation which had been ſuppoſed to exiſt in it, and that the ſubſtances which, in the healthy ſtate, tend to concreſcibility and ſeparation have loſt this property. I do not however conſider it as demonſtrated that the buffy coat proceeds from the fibrin; it appears to me more natural to conſider it as ſuper-oxigenated albumen, which carries with it a portion of fibrin on account of is concreſcible power, whilſt in the natural ſtate it is the fibrin which retains a portion of the albumen.

56. The blood of three ſcorbutic patients, which had been drawn on account of the pain and the plethora which exiſted in theſe perſons, from twenty-nine to forty-ſeven years of age, exhibited to Citizens Deyeux and Parmentier phenomena different from thoſe which had been announced in this liquid. It had neither a greater fluidity than in the ordinary ſtate, nor the abſence of coagulation; it became concrete; its albumen was leſs concreſcible by heat. The coagulum waſhed with water afforded fibrin in elaſtic filaments; upon one of them there was formed a buffy coat, only leſs thick than in the inflammatory blood, and which became friable by deſiccation; the water in which the coagulum had been waſhed, or the colouring part, afforded membranes that floated in it. This blood had not its uſual ſmell: the white ſerum was ſeparated from it in the accuſtomed manner, and was not more abundant than in the ordinary circumſtances. For the reſt, the chemiſts of whom I ſpeak believe that only erroneous inferences can be deduced from the quantity of ſerum ſeparated from the coagulum of the blood. According to them, its ſpontaneous effuſions in the hemorrhages ſo frequent in ſcorbutic patients do not proceed from its fuſion and greater fluidity, but from the weakneſs and relaxation of the veſſels which contain it. There is reaſon to believe, that a want of oxigenation is the principal character of the blood in ſcorbutic patients, and that it is on this

this account that this liquid forms the violet ſpots upon the ſkin, and that the ſea ſcurvy begins with a conſiderable degree of corpulence.

57. The blood taken from the product of veneſection at the arm, performed during the firſt days of the attack of putrid fevers, and in ſubjects with whom the ſymptoms manifeſtly indicated this diſeaſe, preſented to them ſometimes a buffy coat, and ſometimes none; the ſerum generally appeared to them difficult to be ſeparated, and adhering very ſtrongly to the coagulum. They found it likewiſe either very marked analogies with that of inflammatory fevers, or nothing particular; they in vain ſought to diſcover in it thoſe ſigns of putridity with which ſo many authors have aſſerted that is tainted in this kind of affections, and to which they have attributed their cauſe. Diſtilled on the water-bath, this blood afforded them no ammonia, as might have been expected; expoſed to a mild temperature, it did not putrefy more rapidly than the blood of a healthy perſon. According to them, therefore, there does not exiſt in it any particular principle of putridity, which has ſo often been ſaid to characterize the diſeaſes of this kind. It is only in the excrementitial liquors that this tendency to ſepticity, and even an incipient putrefaction, appear in putrid fevers: the blood does not partake of this property.

58. The chemifts, of whofe labours I have juft given an account, have confined themfelves merely to thofe refearches, becaufe the Society of Medicine, to whom they have addreffed their Memoir, had fpoken only of thofe affections in the programma of the prize which has been awarded to them. But how many other important queftions ftill remain to be treated! how many ufeful problems to be refolved in this kind of experiments! The blood has a very remarkable character in thofe purulent difeafes, in thofe great internal fuppurations in which it appears to be converted fo eafily and fo fpeedily into pus. Another prefents itfelf, of equal importance to be determined, in chlorofis or the green ficknefs of young women, whofe arteries and veins are filled with a liquid fcarcely fanguine, of a light rofe colour, and fometimes white. With dropfical patients it has already been feen dry, gluey, vifcous, and brown; it cannot be doubted that it has fuffered a kind of decompofition which fhows itfelf efpcially by the feparation of the ferum; for the water of hydropic cafes has the greateft analogy with this humour. The affections in which the fuper-abundant bile accumulated in its canals, feems to diffufe itfelf into the fanguineous fyftem, as phyficians have long fince obferved, prefent to chemifts an ufeful opportunity for afcertaining whether the means of their art will lead to the demonftration of the prefence

presence of the bile in the blood. The same is to be said of the melaena or morbus niger, of the adipose and lacteal cachexies, and of a multitude of other affections in which the blood assumes a particular character, which is known by the practical observer, and which awaits from chemistry a more exact determination, a more positive definition, than mere inspection has hitherto been able to furnish.

Article III.

Of the Lymph.

1. THE lymph is a white transparent liquid, contained and circulating in an order of vessels very well known at present, the extremities of which, opening into all the cavities, suck in or absorb the liquor effused by the extreme arterial ramifications, and the trunks of which unite with the reservoir of Pecquet and the thoracic duct; so that the lymph appears to be taken up at the extremities of the arteries, and carried into the veins. This humor is one of the most abundant in the body; as the canals which contain it and transport it are extremely numerous. Divided into two general layers, the one superficial and the other deep seated, they exist in all parts of the animal economy, they traverse all its regions; they wind along its surface and between the fibres of the muscles; they cover, and as it were envelope all the viscera.

They

They therefore announce an important function; and the liquid which diftends their conical cavities feparated and contracted from fpace to fpace by valves, muft ferve for purpofes both numerous and neceffary for the fupport of life.

2. Notwithftanding all the intereft which the knowledge of the nature of the lymph muft poffefs for animal phyfics, this knowledge is as yet but very fuperficial or vague, or even erroneous: no author has occupied himfelf with it in particular; chemical fcience cannot yet prefent any analyfis of this humour. From Bartholin and Rudbeck, the firft anatomifts who difcovered thefe abforbent veffels towards 1650, to the laft very extenfive and accurate refearches of Mafcagni and fome other moderns, every thing has been done for the knowledge of the ftructure, the number, the difpofition, and the courfe of thefe abforbent veffels, but nothing has yet been done as to that of the lymph which they convey. Indeed we have not the means of procuring this liquid, as we have of obtaining the blood. Though at prefent the moft of the abforbent veffels have been well defcribed, and though the courfe of a great number of them are known, we are as yet ignorant of the art of extracting the lymph pure; no *lymph-letting* is performed, whereas blood-letting is performed with great facility.

3. Some circumftances of chirurgical difeafes, however, afford opportunities for making experiments upon the lymph. In wounds and ulcerations

cerations of the inguinal and popliteal regions, it ſometimes happens that the trunks of abſorbent veſſels are opened, and that the lymph flows out of them in ſuch abundance, that the clothes and dreſſings are very ſtrongly impregnated with it. I recollect having ſeen two ſuch caſes in an hoſpital in Paris; but I was then too young and too little advanced in this kind of reſearches to have derived the advantage from them which they might have afforded me. Similar circumſtances are perhaps not ſo rare as might be believed; and it is to be hoped that thoſe to whom they may hereafter preſent themſelves, will not let them eſcape without availing themſelves of them for the benefit of the art. Perhaps even, if we ſhould direct our views towards this kind of reſearches, we might acquire the art of opening abſorbent veſſels at pleaſure, and by this kind of lymph-letting imitate what is performed in blood-letting. There is even ground to believe that this ſpecies of operation may ſometime fulfil uſeful indications, remedy lymphatic plethora, diminiſh the maſs of ſuper-abundant white and nutritive juices, evacuate this humour accumulated in the cavities: for the depletion of a large lymphatic veſſel, and the vacuum by which it would be followed, muſt augment the force of ſuction and abſorption in one of the regions, and conſequently in the whole continuity of the abſorbent ſyſtem.

4. Whilſt

4. Whilſt I await the fulfilment of my wiſh, that this idea may ſtrike deeper root in the learned and medical world, I muſt at leaſt collect here what has been ſaid concerning the nature of the lymph. Inſtead of taking this liquid in its own canals, and for want of the humour itſelf which we have not yet been able to extract from its proper reſervoirs, the ſerum of the blood has in ſome reſpect been ſubſtituted in its place, and repreſented as the lymph in moſt works of medicine and phyſiology. Haller himſelf, though otherwiſe ſo exact, and who preferred facts to any hypotheſes, has followed this method. We find it indicated in a great many places of his immortal work, and particularly in the article concerning the ſerum of the blood, and in the ſketch of the chemical claſſification of the humours which precedes his hiſtory of ſecretion. Moſt of the phyſiologiſts who have written ſince him, and who may almoſt all be conſidered as his copiers or plagiaries, have had no other idea. Dehaen, who however has endeavoured in his works to introduce more preciſion into the theory of the humours and of their morbid alterations, has followed this opinion. I know only Bucquet, who, in his Courſe of Lectures, has combated this ſimilitude adopted between the ſerum of the blood and the lymph, and who has inſiſted not to prove that theſe two liquids are not the ſame, for of this we have not acquired any

certainty,

certainty, but to ſhow, that as long as the lymph ſhall not have been particularly examined, we can have no certainty that it is of the ſame nature as the ſerum, and that we are no leſs authorized to ſuſpect it to be different than to aſſert that it is analogous with it.

5. Haller, where he quotes the anatomical and phyſiological labours of Stenon, Bartholin, Drelincourt, Bellini, Wepfer, Werreyen, and Monro, and calls the lymph ſerum, and the ſerum of the blood lymph, indiſcriminately with theſe celebrated men, ranks the latter humour amongſt the gelatinous; but we ſoon perceive that he gives this name of *gelatinous humours* to thoſe which I call *albuminous*, ſince he indicates at the ſame time the concreſcibility by fire as their diſtinctive character. He therefore announces that the lymph is coagulated by heat, by the acids, by alcohol, that it is ſaline, ſlightly viſcous; that it froths by agitation; that it concretes into ſolid flakes by the action of boiling water; that it is ſoluble in cold water; that it yields by diſtillation a fetid oil and concrete volatile ſalt or carbonate of ammonia; that ſalts are found in ſolution in it: in a word, he compoſes its hiſtory and the totality of its properties of all thoſe which belong to the ſerum of the blood. He makes of it really an albuminous humour; he adds that it renders the oils miſcible with water, and he proves it by the abſorption of the fat effected ſo eaſily and ſometimes ſo ſpeedily by the lymphatic

phatic veſſels. He even takes care to diſtinguiſh well from this liquor, as from the ſerum of the blood, the mucous humours which anſwer to thoſe which I call *gelatinous*, as he aſſigns to theſe the character of not being coagutable, but on the contrary fuſible by the action of heat, of being very tranſparent and glutinous. Senac, Queſnay, and Dehaen, had already admitted a like diſtinction.

6. Without denying the poſſibility of this identity, or at leaſt of a very ſtrong analogy between the lymph and the ſerum of the blood, which may in fact be conſidered as its firſt ſource, we cannot however avoid two reflections equally juſt and important: the one that there is wanting to the proof of this analogy an analyſis of the lymph taken in its tubes, and compared with that of the ſerum, as Bucquet ſaid; the other, that even admitting the ſerum of the blood to be the only ſource of the lymph, it is natural to conceive that there exiſt in the latter more or leſs conſiderable differences from the albumino-mucous liquor of the blood, ſince the latter muſt, during circulation by ſerving for ſeveral different uſes, paſſing through different organs, furniſhing ſeveral ſecretions, loſing ſome of its principles, have experienced an alteration ſufficiently conſiderable for it no longer to be capable of being conſidered as having exactly preſerved its primitive nature and compoſition.

7. Were

7. Were we permitted to indulge ourſelves in conjectures founded upon ſome facts which may render them probable, we might believe for example, that by the effects of the fixation of oxigen, of the diſengagement of heat, of the loſs of water, or of hidrogen, and of a portion of its carbon, effects which, having commenced in the lungs, are continued throughout the whole route which the blood takes during its circulation, the blood paſſes gradually into the ſtate of fibrin; that in proportion as this takes place, the albumen which remains without this converſion becomes more oxigenated, more concreſcible, more plaſtic, and that one of its parts diſazoted, diſhidrogenated, and carbonated, forms the animal mucilage or the gelatin. The lymph then, which would be in ſome meaſure the reſiduum of this portion of albumen converted into fibrin, which continues as ſuch, either to conſtitute the blood or to form the muſcles, would contain a portion of highly oxigenated albumen, and a larger quantity of gelatin. Thus the hæmatoſis would terminate by a ſeparation of the blood into three different matters: the one highly azoted, or the fibrin; the ſecond highly oxigenated, or the very concreſcible albumen; and the third highly carbonated, or the gelatin. A portion of the two laſt diſſolved in water would form the lymph, and a portion of the fibrin depoſited with the colouring matter in

in the mufcles would fupport their nutrition and life.

8. But though this conjecture accords well with the knowledge which we have concerning the comparative nature of the three matters which enter into the immediate compofition of the blood; though we fee in many chemical operations upon the animal matters a fort of partition of their primitive homogeneity into two or three different fubftances, it will always be merely an hypothefis till a careful analyfis of the real lymph, compared with that of the ferum of the blood, fhall have decided upon the probable difference which exifts between them, or upon the analogy which has already been fuppofed between thefe two liquids. It muft never be forgotten that our knowledge of the very prompt alterability of the animal liquids renders the difference infinitely more probable than the analogy between thefe two liquids; and that the lymph may very well not be what I have fuppofed it, without on that account being in all refpects fimilar to the ferum, as the phyfiologifts have admitted by a decifion too precipitate and too little founded upon facts not to be an error.

ARTICLE

ARTICLE IV.

Of the Fat, and the Sebacic Acid.

1. THE fat is an animal oil more or lefs fluid and running, or at leaft foft in the living animals, which confequently ought to be ranked amongft the liquids. As it is almoft univerfally diffufed in all the regions of the bodies of animals, I have placed it in the firft clafs of their immediate materials. It is lodged in fmall facs formed by the cellular texture; in which it even affumes, as in a mould, the form of their interior fides. Accordingly, we almoft always find the fat in kinds of lumps or pieces of flat, orbicular or irregularly fquare figures. When we examine it by the microfcope, we fee it formed of veficles filled with a tranfparent humour. Wolf has compared the fats of feveral animals in this point of view. In diffections and when the vital heat is extinct, we find the fat more or lefs folid; but the foftening which it undergoes between the fingers is of itfelf fufficient to prove that it is liquid and running in the organs of living animals; befides, many anatomifts have feen it, on opening the bodies of living animals, in a real ftate of fluidity.

2. The fat has a fweet and faint tafte, a very flight odour when it is hot, a fpecific weight inferior

inferior to that of water, at the top of which it floats. Its tafte is fometimes a little acrid, and its fmell rather ftrong in fome kinds of animals, efpecially in thofe whofe mufcles are black and which naturally ufe violent exercife. Though its colour is in general pretty white, it however varies from the greyifh white to a more or lefs orange-yellow, greenifh or reddifh colour throughout the whole fcale of animals. The fame is the cafe with its confiftence, which extends from the fluidity of an oil to an unctious foftnefs in thefe beings whilft living, and from this foftnefs to a dry and brittle denfity after death and after the ceffation of the vital heat.

3. The fat is found abundantly diffufed under the fkin, where it forms immediately under the cutis a more or lefs thick integument. There is much of it at the furface of the mufcles between the intervals of the different fpecies of thefe organs and in the interftices of their flefhy fafciæ. We alfo meet with a remarkable quantity of it round fome parts of the articulations, in the ball of the eye where it envelopes the mufcles along the veffels of the neck, in the mediaftinum and at the bafe of the heart, round the ftomach and the inteftines. It is efpecially in the vicinity of the kidneys and in the membraneous duplicature of the epiploon that it is accumulated in great abundance. If there be little of it round fome of the mufcles which are conftantly in motion, there is on the contrary a confiderable

considerable proportion of it upon the large muscles of the abdomen, and on the outer part of the buttocks which it partly causes to project in the human species, whilst no animal presents this protuberance of the buttocks. It is also abundant upon the breast, round the mammary glands in women, in whom it determines the prominent, rounded and graceful form of the bosom. The folds of the great articulations also present a remarkable redundance of it, as well as the palms of the hands, the soles of the feet, the tendinous extremities, mucous bags or capsules destined for facilitating the sliding of the tendons. There are very few animals which present any in their brain, upon the forehead, upon the cartilages of the nostrils, of the ears, round the lungs, or the penis; it constitutes in general the twentieth part of the weight of a man. Its quantity varies according to the different animals and according to a multitude of circumstances.

4. Some anatomists have admitted particular organs for the formation of the fat. Malpighi, in describing the adipose glands, believed that there existed also vessels for conveying it into the different parts; but neither the one nor the other of these organs have been seen and confirmed since him. It is generally believed, with Haller, that the fat is separated from the blood in the arteries; that being formed in these vessels it is carried by its specific lightness to the circumference of the sanguineous cylinder which distends

diftends the arteries, and pufhed through fmall orifices, with which their fides are fuppofed to be perforated, into the cells of the mucous texture. In order to prove this opinion, Haller lays great ftrefs upon the phenomena of injections which exude through all the lateral points of the arteries; he adduces that the fat frequently exhibits points and a red tinge of blood extravafated through the fides of arteries after animals have been violently hunted; that Morgagni has feen fat run in drops from divided veffels; that Malphigi afferts that he has feen it in the arterial and circulating blood of frogs, and that Gliffon and Ruyfch have difcovered it in the blood of fcorbutic patients. Reft, abundant nutrition, diminution of the fecretions, and efpecially of perfpiration, the debility and relaxation which follows hærmorrhages, caftration, are the circumftances which favour its formation. A marked difoxigenation in the blood is its primitive fource, according to the principles of the French pneumatic chemiftry, fo well applied by Dr. Beddoes. We fee birds become fat during a fog of fome hours continuance, (qu.) efpecially ortolans, robin red-breafts, thrufhes, &c. The abforbent veffels fuck it up and caufe it quickly to difappear in the animals that fleep during the winter, or in fibrile difeafes, in great fuppurations, during violent exercife, in confequence of the ufe of acrid food the abufe of vinous or fpirituous liquors, mercurial frictions, &c.

5. The

5. The chemical nature of fat was not known till within a few years paſt. Olaus Borrichius was the firſt who paid particular attention in the ſeventeenth century, to the acrid and ſtrong ſmoke which is diſengaged from this ſubſtance when ſtrongly heated, and deſcribed the bad effects which it produces upon perſons who expoſe themſelves to it. In 1740, Grutſmacher, from the action of the powerful acids upon the vegetable oils, conſidered fat as an oil thickened by an acid. His opinion was followed by all the chemiſts down to our own time. Grutſmacher occupied himſelf with this acid of fat in 1748. Rhades, having been engaged in the inveſtigation of animal matters by the inſtances of the celebrated Haller gave ſome details relative to this humour in a Treatiſe publiſhed at Gottengen in 1753. Knape conſidered this acid when rectified as very ſtrong and forming a particular ſpecies. A year after the inveſtigations of Rhades, Leyner gave an account of a ſeries of experiments upon the acid of fat, upon which he publiſhed a particular diſſertation. However, notwithſtanding theſe preliminary labours, D'Aumont did not heſitate to deny, in the firſt edition of the Encyclopedia, the preſence of an acid in the diſtillation of fat. Haller re-eſtabliſhed the truth in the ſupplements which he added ſome years afterwards to the medical articles of that work. Crell, in 1779, publiſhed a long Diſſertation and an extenſive ſeries of experiments upon fat and its acid; he ſhowed

how to extract and purify it; he described its distinctive properties and its saline combinations. Since him, all the chemists have confirmed as well as extended the results of Crell upon the acid extracted from fat. Maret, in the academical courses at Dijon, repeated his experiments and added some facts to them. Citizen Guyton has published an accurate history of them in the first volume of the *Encyclopédie methodique*, or that in which the order of the subjects is followed; he there especially maintains the existence of this acid ready formed in the fats. Citizen Berthollet has proved the presence of oxigen in them, and has ably described the mode of their action upon the metallic oxides. I have also occupied myself with the chemical properties of this animal compound; I have found that the sebacic acid does not exist in it ready formed, but that it requires the decomposing action of fire in order to obtain it; I have shown that the nitric acid oxigenates fat and renders it capable of acting in a very remarkable manner upon the animal economy. It is since this period that it has been employed with success in the itch, in inveterate herpetic eruptions, cutaneous syphilitic symptoms, &c. I have discovered the possibility of explaining its formation, its fusion, &c. by the chemical attractions and the state of the blood in living animals: finally, I have determined the difference of some species of fat.

6. The

6. The firft experiment, or firft procefs which is practifed upon fat, confifts in its purification. It is known that this humour, fuch as it is, extracted from the body of animals, is mixed with cellular texture and with lymphatic veffels, with blood and with gelatinous mucilage; that it is very fufceptible of alteration: In order to purify and preferve it, it is cut into fmall fragments; the moft apparent and the largeft membranes and veffels are feparated from it; it is carefully wafhed, with much compreffion, in a large quantity of water; it is even triturated with water in a mortar; it is melted in a veffel of porcelain or pottery with a fmall quantity of water; this is fuffered to be diffipated till the crackling noife which indicates its paffage through the fufed fat and its evaporation into the air is no longer heard; it is carefully fcummed in order to feparate from it portions of the folid parts which may remain in it; it is poured into a cold and new veffel, in which it becomes fixed in a white, granulated and cryftalline mafs, very fmooth, foft, and fufible between the fingers, which keeps for a great length of time. This operation is principally performed in the laboratories of Pharmacy and the perfumers' work-fhops. with the fat of pork, which is in this ftate called lard or *axungia*. The fat thus purified is more opaque, lefs denfe, and much whiter than in its natural ftate: it retains between its molecules a certain quantity of water which gives it thefe new characters.

7. Fat expofed to a mild fire is liquified, becomes tranfparent, and fixes into fmall, clofe and granulated cryftals by cooling. Its fufion takes place between forty and feventy degrees of the centigradal thermometer, according to the different varieties of this animal matter. It may be melted in balneo mariæ, in order to avoid its alteration when we wifh only to effect its fufion. Heated in contact with the air beyond the heat requifite for fufing it, it quickly acquires a temperature fuperior to that of boiling water; it becomes capable of baking and drying the vegetable and animal matters that are immerfed in it, which are drawn out of it hardened at their furface and deprived of water. Soon afterwards there arifes from it acrid and pungent vapours, which excite a difcharge of tears, and irritate the fauces. This fmoke inflames, and the fat continues to burn till it is reduced into coal. We fee by this that it does not burn till after it has been volatilized, and that it is in order to reduce it into vapour that, when it is employed for lamps, a wick is ufed for the purpofe of conveying into the air the part which has been reduced to vapour.

Fat diftilled on the water-bath affords a certain quantity of water of a faint fmell, in which the different re-agents produce no alteration, and which neverthelefs becomes turbid, depofits flakes, and acquires a fetid odour when it is kept. This water, however, prefents a lefs fenfible alteration than moft of the other animal fubftances;

ſubſtances; it becomes leſs ammoniacal; and it is in general a very marked character of this ſpecies of humour; that it affords much leſs of the latter product than all the other animal compounds; which has induced chemiſts hitherto to ſay that it was an almoſt vegetable matter, or which paſſed almoſt without change from the vegetable aliment into the body of animals. The water which is obtained in this diſtillation of fat on the water-bath was not intirely contained in this humour; a part is formed at the expenſe of the hidrogen and of the oxigen which it contains: on which account, after this mode of action of the fire, the far is perceptibly drier, and of a fawn-yellow or browniſh colour, which announces its commenced decompoſition and the precipitation of the carbon.

8. When we diſtil fat in a retort, we effect its decompoſition in a much more complete manner. This operation has long been performed in the laboratories of chemiſtry: nevertheleſs its real mechaniſm and remarkable phenomena have hitherto been unknown. It has been obſerved, that in this diſtillation the fat paſſed almoſt intire into the receiver when it was heated a little ſtrongly; but there was however diſengaged a ſmall quantity of very acid water, an elaſtic fluid, which Hales reckons to amount to eighteen times the volume of the fat, which was believed to be air, and that there remained a coally mark in the retort. It has

has been feen, that by repeated diftillations of the fublimed fat, there was each time obtained from it a portion of acid water, an oil which gradually became attenuated, a portion of air, and a light layer of coal: it was thence concluded that by repeating this operation the fat would be converted into the ftate of water and of air. It refults from thefe facts, which are now better underftood, that it is into water and carbonic acid, befides a fmall quantity of ammonia, that the fat is reduced completely, and in its laft analyfis; but that in order to arrive at this complete decompofition, it is neceffary to add to this matter when heated a large quantity of oxigen; that it is on this account that the operation advances much fafter in a large veffel than in a fmall one, or that we are obliged to repeat the diftillation a great number of times in fucceffion; finally, that this decompofition refembles, though in another mode and with other phenomena, the combuftion of the fat in open veffels; that when this is performed with care, we have only water and carbonic acid as products; that when it is effected only in part we obtain from it, as in diftillation, an acid vapour, a portion of oil not decompofed, but merely volatilized, and a coally, or fungiform concretion of coal, which collects upon the wick, and prefent a new obftacle to this phenomenon; that thus the products of the diftillation of the fat in the retort, the phlegm, the febacic acid, the gafes,

gafes, the more or lefs liquid oil, are kinds of compounds intermediate between this body and the water, and carbonic acid, which are the ultimate terms of its decompofition; that their proportion muft vary according to the force of the decompofition that is effected, according to the temperature that is employed, the fize of the veffels, the quantity of air which they contain, the manner in which the fire is managed, &c.

9. Thefe general notions ferve to enable us alfo to conceive and explain what the different chemifts have written concerning the diftillation of fat. Neuman, one of the firft who has well defcribed this operation, diftilled comparatively the fats of the bullock, the fheep, the hog, and the goofe: he employed 1152 parts (grains) or two ounces of each of thefe fats. That of the bullock gave him fixty parts of phlegm or empyreumatic and acrid liquor, of which he has not however indicated the acid nature, 852 parts of oil, and eighteen of coal. From the fat of fheep he obtained ninety parts of phlegm, 854 of oil, and 16 of coal; from that of the hog, 70 parts of phlegm and 880 of oil; and from the fat of the goofe, 60 parts of empyreumatic water, 890 of acrid oil, and 10 of coal. He confidered this coal as earth; he took no account of the elaftic fluids, and he did not know the febacic acid. Hoffmann believed that the product of the diftillation of fat was alkaline, as it turned copper

 blue.

blue. Segner obtained from four ounces of human fat, heated to 600 degrees of Fahrenheit's thermometer, or 270 of Reaumur, 100 drops of phlegm, the acidity of which he has indicated, as well as Vogel: he has obferved that this product reddened the blue colour of violets, that its ftrong odour was obnoxious to the brain: that there remained in the retort, after he had obtained it, a concrete and blackifh oil.

Crell performed the diftillation of the human fat in a more careful manner: twenty-eight ounces, heated in a glafs retort with the fand-bath, yielded, after having melted at the 115th degree of Reaumur's thermometer, an infipid phlegm; at 220 degrees, an inflation took place, which did not appear in the fat of the bullock; there were difengaged two liquids, a brown and liquid oil upon a water of a gold-yellow colour, befides an oil fixed at the bottom of this water. The operation lafted twenty-one hours: all the products had a ftrong fmell. By diftilling them over again, he obtained twenty ounces, five drachms, forty grains of fluid oil; three ounces, three drachms, thirty grains of acid phlegm; three ounces, one drachm, forty grains of brilliant coal, five drachms, ten grains lofs.

We eafily perceive, in the differences of the proportions between thefe different analyfes, the truth of what I have advanced concerning the varieties of the mode of operating, of the temperature,

perature, of the form and ſize of the veſſels, concerning the rapidity with which the heat is applied, the repetition of the diſtillations, &c.

10. Fat kept in the air becomes the more altered in it the more multiplied the points of contact between them are, and the hotter the atmoſphere is; it acquires a yellow and ſometimes an orange colour; it aſſumes a pungent odour, which is known by the name of a *rancid ſmell*, with an acrid and manifeſtly ſour taſte. This kind of rancidity, which is owing to the development of an acid, ſuppoſes alſo the fixation of a portion of oxigen; it appears that it proceeds from a fermentation which eſtabliſhes itſelf in the gelatinous ſubſtance, which accompanies even the purified fat, which re-acts upon the adipoſe ſubſtance itſelf, which developes in the latter ſebacic acid, and perhaps a ſmall quantity of acetous acid in the firſt. The water in which rancid fat is waſhed acquires an acrid taſte, and the property of reddening the blue vegetable colours. Mr. Poerner employed this liquid in order to purify it. Alcohol equally poſſeſſes this property, according to Citizen Machy. However, both of theſe agents diſſolve a part of the fat at the ſame time with its acid, and the fat, though well waſhed, retains a portion of the latter. Theſe obſervations already prove that the ſebacic acid, developed in the ranceſcence of the fat, was not contained ready formed in this ſubſtance, but that it is formed by the fermentation itſelf which

which it has undergone. However little rancid the fat may be, we fee that it acquires properties very different from thofe which it poffeffed previous to this rancidity, and which it muft however have in part, at leaft, if it naturally contained febacic acid ready formed.

11. Fat mixes very well with fulphur by fimple trituration; it diffolves it with the aid of fufion, and affumes a pretty ftrong confiftence by this union, which forms the fulphurated ointment. When we heat this fulphurated fat, we do not obtain from it any fublimed fat, but a large quantity of fulphurated hidrogen gas and of fulphureous acid, becaufe a high temperature, by favouring the decompofition of the fat, transfers a portion of its oxigen to the fulphur, which it burns in part, and of its hidrogen to the fame body which it carries off in the gafeous form.

The cafe is the fame with phofphorus, which is diffolved very eafily in the heat by melted fat. It is difficult to feparate the phofphorus from this combination: it is, however, not fo much fixed in it as the fulphur; but it is alfo difengaged from it by the action of heat in the ftate of phofphorated hidrogen gas. In performing this experiment, it is neceffary to employ precautions in order to prevent the detonation and fudden inflammation which may be produced by the phofporated compound.

Fat acts even in the cold upon fome metals, the oxidation of which it effects, or at leaft favours,

favours, when it is triturated with thefe bodies reduced into fmall particles, and in contact with the air. This effect is particularly perceptible in the preparation of the mercurial ointment, which confifts in triturating running mercury with hog's lard. We fee this metal gradually lofe its metallic form and liquidity, and the fat acquire a black colour. Though in this extinction it was at firft thought that the mercury was only divided, as we always fee metallic globules in the beft prepared ointment, it is certain that it is a real black oxidation of the metal, becaufe it takes place much more fpeedily when we add to the fat red oxide of mercury, fuper-oxigenated muriate of mercury, or when, inftead of fimple lard, we take oxigenated fat, as I fhall indicate hereafter, when we aid this extinction by highly oxigenated animal matters, fuch as faliva. The fat acts in the fame manner upon copper, which it very quickly converts into green oxide. This phenomenon is very perceptible with wax, which indeed is one of the moft highly oxigenated adipofe fubftances.

12. Water does not diffolve fat, and when we employ it in order to wafh and purify it, it is only in order to feparate from the blood and other foluble matters which it contains. When fat is boiled in water it melts, and the aqueous liquor then diffolves the membranous laminæ, and the cellular texture which are interpofed in it; fo that if the water be in fmall quantity,

and

and we afterwards ſuffer it to cool, it concretes into a jelly. I have already ſaid, that a portion of this liquid is interpoſed between the molecules of the fat: ſo that after the cooling and condenſation of the latter, it is in a granulated form, more light, white, and opaque than it was before. It is neceſſary to heat it afterwards for a long time, in order to ſeparate from it this portion of water, which eſcapes with a crackling noiſe till the laſt particle. Another effect is produced by the water when the fat is boiling and violently heated, when it is on the point of being inflamed, and eſpecially when it is ſo already. Water thrown upon fat thus heated frequently produces a conſiderable exploſion, and greatly augments its inflammation, which is owing to a real decompoſition of the water effected by the red-hot carbon, and the rapid diſengagement of the carbonic acid, and of the hidrogen gas, which are the product of this decompoſition. On this account water, ſo far from being able to ſtop the burning of inflamed oils and fats, only gives greater activity to the combuſtion, and augments its ravages,

13. Fat acts with the aid of heat, upon all the metallic oxides, and reduces them at firſt by becoming itſelf oxigenated, and afterwards by being decompoſed. This effect is obſerved in the preparation of ointments and plaſters. It is the ſame as that which I have deſcribed in the hiſtory of the oils. Many metallic oxides,

oxides, especially those of lead, copper, and iron, are soluble in hot fat; they give it consistence and heat; they form with it kinds of insoluble soaps; it is therefore dangerous to melt fat in earthen vessels glazed with the oxides of lead and of copper.

The powerful acids, and especially the sulphuric and the nitric, act in a very remarkable manner upon fat, whilst the weak and little decomposable acids, or those which yield their oxigen with difficulty, do not cause it to undergo any alteration.

The concentrated sulphuric acid turns fat brown, and reduces it to coal in a perceptible manner in the cold: its action stops when it has formed in it a sufficient quantity of water to be saturated with it. In the heat it goes much farther; there are disengaged sulphurous acid gas, carbonic acid gas, and sulphurated hidrogen gas. The fat is afterwards in a great measure decomposed, and there remains of it only a small black portion having little consistence.

The nitric acid acts but very little in the cold upon the adipose compound. In the heat, at the temperature at which the fat melts, nitric acid, at 32 degrees of the aërometer, is decomposed, yields oxigen to it, gives it an orange-yellow colour; there is disengaged a small quantity of nitrous gas, and azotic gas; it is in this manner that we obtain the oxigenated ointment, which I first proposed several years ago, to be substituted instead of the unguentum

citrinum, and which Citizen Alyon has fince found fo ufeful in the itch, in old herpetic eruptions, and in venereal affections of the fkin. He prepares it by taking fifteen parts of fat, and one part of the acid indicated, by caufing them to act at a mild heat till an ebullition takes place, by withdrawing the mixture from the fire, and by agitating it confiderably whilft it is cooling. There may be many degrees of the oxigenation of the fat, according to the form and the quantity of the acid which is employed. If we employ three or four parts of nitrous acid to one of fat, and heat it ftrongly, we decompofe thefe two bodies; the fat becomes fenfibly brown, febacic acid and a little oxalic acid are formed, whilft much nitrous gas and carbonic acid are difengaged, without mentioning the water which is difengaged at the fame time. Amongft the different oxidations which the fat is made to undergo by treating it by this acid, of different ftrengths, at different temperatures, and in varied dofes, there is one which approaches fo near to the drynefs of wax, that there is reafon to hope we fhall at fome future period, be able to give it this character in our manufactures. The fat oxigenated to the ftate of ointment or pomatum extinguifhes mercury five times fafter than natural fat, and may ferve with great advantage for the preparation of the *unguentum citrinum:* it is alfo fufceptible of quickly oxiding copper, which it diffolves with the aid of heat, and with which it foon forms a

fort

ſort of brown ointment; it is ſoluble in alcohol, &c. We may oxigenate fat by means of the oxigenated muriatic acid.

14. The cauſtic alkalis have a very ſtrong action upon fat; they eaſily reduce it to the ſaponaceous ſtate. This kind of animal ſoap may ſerve for all the purpoſes of economy, and it is manufactured of this kind in ſome countries. Ammonia does not exert any ſuch action upon the adipoſe compound. Lime, barites, and ſtrontian, combine with it, and conſtitute earthy, hard, ſolid, and inſoluble ſoaps. Theſe compoſitions are ſometimes employed in the fabrication of mortars or cements, and they give them a conſiderable ſolidity, and the property of receiving a ſoft and unctuous poliſh. The ſoaps of fat, when burned by a violent fire, are reduced to coal and afford alkaline and earthy ſebates, which ſome modern chemiſts have believed to be all formed in the original ſoaps, but which are really formed only by the high temperature which burn and decompoſes the fat. I ſhall ſoon ſpeak of them again in treating of the ſebacic acid. The ſalts have no action that is known upon fat; the muriate of ſoda preſerves it, and keeps it for a conſiderable length of time from becoming rancid.

15. The metallic ſalts and ſolutions exerciſe in the heat upon melted fat, an action which has long been known in the laboratories of pharmacy, where ſeveral compoſitions of ointments or plaſters, are prepared with theſe matters: it is eſpecially exemplified with the nitrate of

mercury

mercury in ſolution. When we pour this ſolution into melted fat, and agitate the liquid, there is ſuddenly formed a yellow precipitate, and the mixture, as it cools, aſſumes a ſolid conſiſtence, preſerving its colour; on which account it has been called the citron-ointment. The oxide of mercury in this compoſition quits the nitric acid, and paſſes into the ſtate of yellow oxide; the fat is oxigenated by the acid, and itſelf aſſumes a ſimilar tinge. We ſee azotic gas diſengaged in ſmall bubbles. All the metallic nitrates, and moſt of the ſalts and acid ſolutions of the metals, preſent either a ſolution or a decompoſition by melted fat. Several of them even unite well with it in the cold and by ſimple trituration. This kind of combination which as yet is little known, and the reciprocal action which accompanies it, deſerve to engage the attention of the chemiſts, and muſt afford, by new reſearches, uſeful matters to the arts, as well as new reſults to the theory of the ſcience.

16. Fat combines with a great number of vegetable and animal ſubſtances: it eaſily diſſolves the extracts, the green colouring parts, the balſams, the reſins, and the gum-reſins, as we ſee in the preparation of a multitude of ointments and plaiſters; it obſtinately retains all the odorous materials of thoſe bodies, as is proved in the art of perfumery; it ſtops the alteration of which theſe ſubſtances are ſuſceptible and preſerves them for a great length of time;

time; it unites with elaſtic reſin though with difficulty. Alcohol has no action upon it, at leaſt unleſs it be rancid or oxigenated; however, ſome ſpecies of adipoſe ſubſtances, amongſt thoſe which naturally contain the moſt oxigen are capable of diſſolving in it. The mucilages combine with melted fat, and communicate to it that kind of ſoftneſs and unctuoſity which characterizes ſome ointments. The gums triturated with fat render it ſoluble, or at leaſt capable of remaining ſuſpended in water. It is capable of uniting by fuſion with the oils, to which it communicates a part of its conſiſtence. Tannin appears alſo to be ſuſceptible of combining with fat, though this kind of combination has not yet been ſpoken of. Finally, the albuminous animal liquors unite alſo with it by long trituration, and it is through their mediation that the fat is taken up again by the abſorbent veſſels and carried back into the circulation. Haller has obſerved that ſome purulent humours, which are only a compound analogous to thoſe which I here indicate, have the fatty character and inflame when they are heated.

17. I have announced, in ſeveral of the preceding articles, that fat affords, by its decompoſition by fire, a particular acid, which has been called *ſebacic acid*, as it is obtained in conſiderable abundance from tallow. This product deſerves a particular deſcription. Crell has occupied himſelf the moſt with this ſubject of all the chemiſts. After having found that

 it

it was conftantly difengaged during the decompofition of fats by fire, he endeavoured to find the means of purifying it; but he met with great difficulty to feparate the oil which accompanies it. Having employed diftillation with the view to concentrate it, he obtained a very acid water, and was convinced that it was more volatile than this liquid. He faturated the acid product of fat with pot-afh, evaporated the liquor to drynefs, and heated the refiduum in a crucible till it afforded no more fmoke; and till it diffolved without colour, by precipitating carbon during its folution in water. This fecond folution being evaporated afforded him a foliated falt which he diftilled with half its weight of fulphuric acid, and he thus obtained a fuming acrid acid, in the proportion of one-twentieth part of the falt employed. When this falt had not been fufficiently calcined it gave him by the fulphuric acid an oily liquid of a gold-yellow colour mixed with the acid liquid. He employed an ordinary copper alembic for diftilling the fat and obtaining from it the acid liquid, as well as the fluid oil; but this procefs did not anfwer his purpofe; the acid retained copper, and the tinning of the capital was melted; he therefore endeavoured to find another procefs than the diftillation and the faturation of the product of the fat by the fixed alkali in order to procure the febacic acid. The following is that which he adopted after many attempts.

18. Per-

18. Perſuaded, with all the chemiſts, and eſpecially Cartheuſer, Macquer, &c. that the ſebacic acid exiſted ready formed in fat, he propoſed to fix it by means of the alkalis immediately and independent of diſtillation. He made a ſoap of fat with pot-aſh, of which he mixed ten pounds in a gelatinous ſtate with 22 ounces of diſſolved alum; by ſeparating the liquor from the precipitate formed by the inſoluble aluminous ſoap, and evaporating it, he extracted from it twenty one ounces of ſebate of pot-aſh, mixed with ſulphate of the ſame baſe. It was from this ſalt diſtilled with the ſulphuric acid that he extracted the ſebacic acid; he rectified it upon a quarter of the ſalt preſerved for this purpoſe. He aſſured himſelf that this rectified acid contained no ſulphuric acid by trying it with the acetite of lead; the precipitate which he obtained ought to diſſolve entirely in vinegar if it was only ſebate of lead, and not diſſolve intirely in it if it were mixed with ſulphate of lead.

Citizen Guyton has deſcribed another more eaſy and more ſimple means for obtaining the ſebacic acid. This means conſiſts in treating the fat with quick lime, by mixing this cauſtic earth in powder with melted fat; the mixture is left to cool, the ſoap is waſhed with a large quantity of water, the ley is filtrated and evaporated; the brown calcareous ſebate which is the product is ſtrongly calcined in a crucible, then lixiviated, the ſolution filtrated, the

ſuper-abundant lime is ſeparated from it by the carbonic acid, and it is afterwards evaporated by diſtilling the white and pure calcareous ſebate which it affords with ſulphuric acid, pure ſebacic acid is obtained. It appears evident to me, thathere, as in all the proceeding caſes, the ſebacic acid is the product of the great alteration which the fat ſuffers from the fire, that it is not contained ready formed in the fat, and that the calcinations to which the alkalis and the lime, as well as the fat, are ſubjected, when under pretence of purifying the ſalt it is very briſkly heated, are the true cauſes and at the ſame time the proofs of the formation of the ſebacic acid. In my opinion it is neither a ſebate of pot-aſh nor a ſebate of lime: it is not a ſalt but a real adipoſe ſoap which is heated, and which then leaving the animal oil to be decompoſed, preſents the earthy or alkaline ſubſtance to abſorb and fix the portion of ſebacic acid which is formed. No fact proves that pure fat contains this acid; it is only by a conjectural theory that it is admitted, whilſt on the contrary, every thing proves that in order to prepare it, it is neceſſary to decompoſe the fat and combine its conſtituent principles in another order.

19. Crell extracted ſebacic acid to the amount of a little leſs than one fourth of the fat, by treating it according to the proceſs that has been deſcribed. By examining this acid by different means, he began to imagine that it was the ſame

as the muriatic, becaufe it had given him with foda a falt fufible without decompofition by fire, and it acts upon gold with the aid of the nitric acid, precipitates the nitrate of filver, fublimes with mercury, and its folution is not decompofed by the muriate of foda, and becaufe its combination with antimony is precipitated by water. But Citizen Guyton on comparing this febacic acid with the muriatic acid under other relations, has found more differences than refemblances between them; he has befides judicioufly obferved, that a fingle chemical property conftitutes a fufficient difference between them to prevent their ever being confounded together. According to him, the febacic acid combined with foda cryftallizes in needles, not in cubes like the muriate of foda; it forms no deliquefcent falt with iron; it attacks running mercury; it precipitates the oxigenated muriate of mercury, as well as the muriate of foda, the bafe of which it retains whilft it difengages its acid by diftillation; laftly, alum is not decompofed by the febate of lime, which is alfo one of the moft diftinguifhing characters of this acid. According to thefe principal differences, Citizen Guyton does not hefitate to confider it as a particular acid different from all thofe that are hitherto known.

20. The febacic acid appears to be formed generally by the decompofition of all the oily bodies, fince Mr. Crell obtained it by diftilling butter of Cacao; however it is more eafily and

and more abundantly produced by all the fats; thus the German chemiſt whom I have mentioned has extracted it eſpecially from ſpermaceti. Though the intimate nature of the ſebacic acid, has not yet been determined, what we known of its formation permit us to ſuſpect that it is not, like the Pruſſic and zoonic acids, a real animal product, or compound of a triple radical of hidrogen, carbon and azote, all united with oxigen. Of whatever nature it may be, the following are properties which diſtinguiſh and characterize it. It has an acrid ſuffocating odour, which irritates the eyes, the noſtrils and the throat, by which it is eaſily recognizable. It exhales a white vapour or ſmoke when it is well concentrated; it reſembles in its conſiſtence and aſpect an oily liquor, whence its origin is rendered apparent to the eye. It ſtrongly reddens the tincture of turnſole, and perceptibly even that of violets. It is very volatile, aſſumes a reddiſh colour by the action of fire, and leaves at each diſtillation employed for rectifying it, a brown liquid, or a coally trace when the operation is carried on to dryneſs. It is entirely decompoſed in a red hot tube, and converted into water, carbonic acid, carbonated hidrogen gas and coal.

21. Its combinations with the alkaline and earthy baſes, or the ſebates, have traits of reſemblance with the acetites according to Bergman; Citizen Guyton however obſerves, that they are more fixed in the fire and leſs alterable

alterable by the air. The ſpecies of theſe ſalts have not yet been well deſcribed; we only know that moſt of them are cryſtallizable in laminæ, conſiderably ſoluble, decompoſable by the ſulphuric acid; it alſo appears that the order of the attractions of the ſebacic acid for the baſes, preſents ſucceſſively barites, pot-aſh, ſoda, ſtrontian, lime, magneſia, glucine, alumine and zircon, like moſt of the powerful acids, eſpecially the ſulphuric, nitric and muriatic. Some remarkable facts have been collected relative to the attractions of ſeveral of the ſebates. The ſolution of ſebate of lime does not render that of alum turbid, which proceeds from the weak attraction of the ſebacic acid for alumine. This acid, diſtilled with the alkaline ſulphates, diſengages from them ſulphureous acid whilſt it becomes decompoſed. It precipitates the ſolution of tartrite of pot-aſh in tartareous acidule. It decompoſes the nitrate and the acetite of pot-aſh by diſtillation, but it does not attack the muriate of ſoda. It appears to be capable of attacking glaſs and diſſolving a part of it, as it deprives the veſſels in which it is diſtilled of their poliſh, and afterwards depoſits by digeſtion ſiliceous earth. The ſame effect has been ſeen in the pyromucous acids.

22. The ſebacic acid exerts a ſufficiently marked action upon many metallic ſubſtances. Diſtilled upon the arſenious acid it reduces it into metal, as is alſo done by the entire oil and

fat. It does not attack either cobalt, bifmuth or nickel, even by long continued digeftion. It precipitates the nitro-muriatic folution of antimony, which in fact is decompofed by water alone in very large quantity. It combines with mercury and filver, when it is brought to act upon thefe two bodies in the metallic ftate. The febate of filver is precipitated by the muriatic acids, whereas the febacic acid decompofes the nitrates of mercury and of filver, the fulphate of the latter, and even precipitates the folution of oxigenated muriate of mercury in a white powder. It equally precipitates the nitrate and acetite of lead, but not the fulphates and nitrates of zinc, of iron and of copper. It attacks gold very feebly, but it diffolves it very well when it is combined with the nitric acid. This is one of the facts which chiefly led Mr. Crell to infer a great analogy between this acid and the muriatic. Combined with the oxide of gold, the febacic acid forms a cryftallizable falt, as well as with the oxide of platina; it precipitates both from their nitro-muriatic folutions.

The German chemift, difpofed according to all his experiments, to rank the febacic acid amongft the moft powerful of thefe bodies, announces that it acts even upon the oils, which appears to depend upon its oily nature, and that he has fucceeded in obtaining ether by treating alcohol with this acid.

23. I have defcribed all the known chemical

properties

properties of fat in general; I muſt now give an account of the differences which it preſents, as well with reſpect to the different regions which it occupies in the ſame animal, as with reſpect to the age of the animal, the different orders of animals, and laſtly, in its morbid alterations.

The variety of the characters which fat preſents, according to the different regions in which it is conſidered, is a fact well known to anatomiſts. It is more ſolid under the ſkin and in the vicinity of the kidneys; it is leſs ſo, and it even runs like an oil, between the muſcular fibres, or in the vicinity of the moveable viſcera, ſuch as the heart, the ſtomach and the inteſtines. It has a granulated character round the articulations, and in the interior of the corticular capſules. Haller has found it almoſt as hard as a calculus, or what is ſo improperly called a *ſtone of the bladder*, within the leg and along the internal oſſeous ſurface of the tibia.

24. Age cauſes the fat to vary very ſenſibly. Haller found none of it in the epiploon of a fœtus of four months. According to Ruyſch and Diemerbroeck, inſtead of real fat, there is only a kind of tremulous and gluey jelly under the ſkin of the fœtus; afterwards there is formed a ſmall quantity of granulated fat. This humour augments rapidly after birth; in the firſt year of life the human body is extremely fat; the fat under the ſkin is for a long time white; it grows yellow with age; it is extremely

tremely ſoft in the female ſex. At the age of forty years, its quantity exceeds that which it has at any other period of life. This period is that of a real adipoſe cachexy. At the commencement of old age it melts, and ſuffers the ſkin which till then it had ſupported in a ſtate of tenſion, to collapſe as it were into a faded and wrinkled condition. The ſmall quantity of fat which remains in old men is hard, conſiſtent, of a deep yellow colour, ſometimes approaching to a brown. The ſame adipoſe phaſes take place in animals as in man: they however vary with them according to their nature, the ſtate of their blood, and the mode of their reſpiration.

25. The fat of the mammalia in general does not differ much from that of the human ſpecies. It has been obſerved that in the frugivorous and herbivorous animals it is more firm and more ſolid than in the carnivorous. It is to the firſt that the lard and tallow particularly belong. Spermaceti is a kind of fat which is extracted from the head and the ſpinal canal of the cacholot, and which is characterized by a dry and friable adipocerous conſiſtence, by a cryſtalline, lamellated and brilliant form, by its fuſibility inferior to that of ordinary fat, and by its ſolubility in alcohol. Of this I ſhall ſpeak more hereafter in detail. I here conſider it in general, becauſe this fatty ſubſtance is found in many other animal matters beſides the head of that ſpecies of whale.

The fat of birds is fine, mild, unctuous, and very fufible. In fifhes it is almoft fluid or oily: it depofits adipocire.

It exifts in infects, worms, and the teftacea; in thefe it efpecially accompanies the vifcera of the abdomen, where it is placed in fmall lumps: it is alfo found, though more rarely, under their fkin.

26. Difeafes have an influence upon the fat; it is itfelf fometimes the caufe of maladies. Its abundance conftitutes a morbific affection; it has been known to augment the average weight of a man, which amounts to 80 kilogrammes, to 300. It fometimes preffes the heart, and retards and even ftops its motion; it obtunds the nervous fenfibility; it difor- ganizes the mufcles; fometimes their fibres are found converted into fat; it melts in moft difeafes, and feems to ferve as nourifhment during the torpid ftate of men and animals: thus the dormoufe, the marmot, &c. go into their holes very fat, and come out very meagre after the hibernation. After difeafes, efpecially of the febrile kind, man is extremely meagre; much time is not required for the fat to be formed again. Some fmall birds become extremely fat during a fingle night when there is much fog. It affumes a yellow or green colour from the admixture of bile, which appears to have much relation with fat. It is fometimes feen to flow off with the excrements in difeafes. When the external part of the body of animals is

is made to grow lean by extreme heat, it is obferved that their liver increafes confiderably in fize. We fhall foon fee that this vifcus is in fact of an adipofe nature.

27. Fat fulfils a great number of ufes in the life of animals; it maintains the heat of the parts by preventing the caloric, of which it is a bad conductor, to be difengaged outwardly; it is known that fat perfons are lefs fenfible to cold than lean ones. Galen mentions a perfon who always felt cold in the abdomen after having loft a part of the epiploon by a difeafe. Macquer thought that it ferves to abforb the fuper-abundant acids of the body of animals; but he founded this idea upon the concrete ftate of the fat, which he believed to be owing to a combination of acid, and it is now known to be an error. This fubftance appears rather to abforb the fuper-abundance of hidrogen, and to be formed when the oxigenation is too little confiderable. By its unctuous quality, fat facilitates the fliding of the parts upon one another; it prevents the fibres from being glued together. It determines the rounded, graceful, and foft forms of feveral parts: it diftends and fupports the fkin, at the fame time imparting whitenefs to it; it fills up vacuities and intervals between many fibres, textures, or organs. It renders the bones flexible and pliant; it paffes from one part into another with much facility; it is abforbed by the lymph, which renders it foluble; it in part nourifhes animals, who

who thus support themselves upon their own substance at their own expense.

28. Fat is employed for a great number of economical uses. It not only serves as seasoning to a great number of aliments, to which it communicates a mild unctuous quality; but it also is itself an aliment, and has very decided advantages in cases of a too high oxigenation of the system. It may therefore be administered in medicine, not only as has hitherto been done, as a lubrefacient, emollient, relaxant, and lenitive remedy, but also as a disoxigenating medicine, or one which absorbs that super-abundance of oxigen, which manifestly, exists in inflammatory diseases.

The numerous uses are sufficiently known to which it is applied in currying leather, in facilitating the motion of machines, in plasters, in some mortars, &c. Every fat has, as is well known, its particular utilities.

Article V.

Of the Transpiration, of Sweat, and of the Humour of the internal Cavities.

1. THE insensible transpiration (a word which is sometimes taken for the matter which issues in the form of vapour from the surface of the skin, and sometimes for the function itself by

by which this exhalation is effected) is one of the evacuations with which physicians have been the most occupied, and of which physiologists have not perhaps availed themselves so much as the former have done for the theory and practice of their art. There is no phenomenon in animal life which has given rise to more researches and explanations, or which has excited so much interest amongst philosophers. It was known by Hippocrates, Theophrastus Erasistratus, and Asclepiades, who called it *pneuma*, because they knew that it had the form of air. Galen has made it one of the bases of the pathological etiology. Sanctorius acquired, at the commencement of the seventeenth century, an immortal reputation by publishing the result of his long experiments upon transpiration, and the exposition of its influence upon health and diseases. His Medicina Statica, published in 1614, does not however contain the detail or the description of his experiments, but only aphorisms of which we do not always see the relation with the experiments themselves, as these remain unknown; but at that period natural philosophy did not exist; and too little attention was then paid to experiments for it to be thought necessary to present their detail, and an account of the manner in which they were conducted to the readers.

2. Towards the end of the same century, in 1668, Dodart, a physician, and member of the Academy

Academy of Sciences of Paris, which had juſt been eſtabliſhed in 1668, communicated to it his reſearches upon tranſpiration: he contented himſelf, like Sanctorius, with giving reſults, and comparing them with thoſe of Sanctorius, in order to determine the differences preſented in this reſpect by the climate of Paris, ſituated at forty-nine degrees of latitude, compared with that of Venice, at forty-nine degrees, where Sanctorius had made his. J. Reil repeated ſimilar experiments during ten years at Northampton, ſituated at fifty degrees, and he was the firſt who publiſhed the detailed journal of them. Bryan Robinſon did the ſame in Ireland; G. Rye at Cork, and Linings in South Carolina, at thirty-three degrees of latitude. When we compare thoſe labours of more than a hundred years, which have not been continued during nearly ſixty years paſt, though this kind of reſearch promiſes, eſpecially for the laſt thirty years, many more important reſults than could have been formerly obtained, on account of the more advanced ſtate of the ſcience, we find unfortunately, together with ſome general truths, much uncertainty, contradiction, and error. Haller ſhows, in his great work of Phyſiology, that the authors of theſe experiments have not taken all the poſſible precautions, that they have neglected both the ſaliva and the pulmonary abſorption. He reproaches Sanctorius himſelf, who however has acquired ſo much fame, and who will always deſerve it in the memory of mankind,

mankind, for having firſt made experiments, for having firſt conceived the idea of meaſuring the quantity of the tranſpiration by weight, and of placing the medical theory upon a ſure foundation; he reproaches him, I ſay, for having allowed too much to the tranſpiration, and for having forced the reſults in order to adapt them to the Galenic theory of which he was a follower.

3. In modern times I find only Lavoiſier and Seguin, who, having aſſociated together in order to examine the phenomena of tranſpiration, contrived to meaſure in particular and ſeparate from each other, by means both ingenious and exact, that which takes place in the lungs, and that which is effected by the ſkin, and to compare their relative quantity. We owe to them ſome important reſults; but only in a general way. Their reſearches, of ſome hours or ſome days only, do not preſent the long ſeries of thoſe of Sanctorius, of Dodard, of Kiel, of G. Rye, or of Robinſon, though they are far ſuperior to them in accuracy and preciſion. The French philoſophers have deſcribed with much care the means and the inſtruments which they have employed for making their experiments; and hence we may judge of the difference between them and thoſe of the phyſiologiſts who had preceded them in this career. Moſt frequently Citizen Seguin himſelf was the ſubject of theſe experiments. The balance which he employed, the beam of

of which was four feet and a half in length, was so accurate, that when charged with 125 pounds or 62½ kilogrammes on each side, it was turned by a weight of two grammes, or half a drachm (gros). He placed and inclosed his whole body in a sack of varnished silk, which having been blown up with air, had lost nothing during fifteen days. This sack was tied close above his head: it had an aperture which was accurately glued round his mouth with a mixture of turpentine and pitch. The mouth being thus open, and communicating with the atmosphere, the pulmonary transpiration passed into the air, and that of the rest of the skin collected in the sack, which let nothing escape. By weighing himself twice at certain intervals of three or four hours, he found the weight of the pulmonary perspiration in the diminution which the balance gave him; by afterwards weighing himself in the sack likewise at certain intervals, and twice in succession, he had the weight of the cutaneous transpiration by subtracting from the total loss that which he had found by the pulmonary transpiration, and always comparing the aliments and excrements with the loss in invisible effluvia. Hitherto in these experiments means were not sought for ascertaining the nature of the transpired fluid, and only the determination of its quantity was had in view. I shall show elsewhere by what ingenious machines the same modern philo-

 sophers,

fophers, Lavoifier and Seguin, have fucceeded in carefully analyzing the phenomena of refpiration.

4. Though the refults obtained by thefe different experiments have pretty confiderable differences from one another, without prefenting them in all their details, as Haller has done in his great work, it is neceffary at leaft to indicate the general refults. In the northern countries, and according to the experiments of G. Rye, during the three winter months, there pafs out of the body 4797 ounces of perfpiration, and 3937 of urine; during the three fpring months, 5405 ounces of perfpiration, and 3558 of urine; in the three fummer months, 5719 ounces of perfpiration, and 3352 of urine; finally, in the three autumnal months, 4471 of perfpiration, and 3369 of urine. In a day of the winter there are, according to the fame experiments, 53 ounces of perfpiration, and 42 of urine; in a day of the fpring, 60 ounces of perfpiration, and 40 of urine; in a day of the fummer, 63 ounces of perfpiration, and 37 of urine; finally, in a day of the autumn, 50 ounces of perfpiration, and 37 of urine.

According to the refults of Keil, there are 31 ounces of perfpiration, and 38 of urine, fo that the latter exceeds the former.

Dodart had found that the proportion of the tranfpiration to that of the folid excrements, was as 7 to 1, and to all the fenfible excrements in

in general as 15 to 12. The medium quantity of perſpiration in France was, according to him, an ounce an hour.

Robinſon eſtimated, according to his experiments, that in youth the perſpiration was to the urine as 1340 to 1000, and in old age as 967 to 1000.

Hartman obtained, in analogous experiments, the following reſult: from 80 parts (ounces) of aliments eſcape by perſpiration 35, by urine 28, and by the ſolid excrements ſeven. According to Gorter, the proportion of theſe relations is ſuch, that of 93 parts of aliment 49 paſs by the ſkin, 36 by the urine, and eight in the ſolid excrements. We ſee, therefore, that there are differences between the reſults of all theſe experiments made in cold countries.

5. The reſearches upon the perſpiration in warm climates preſent almoſt an equal number of uncertainties and differences, though the experiments being leſs numerous afford reſults more eaſy to be brought to agree with each other. We are indebted for them chiefly to Sanctorius. He made them during nearly thirty years at Venice, where the air is hot and moiſt. His general concluſion is that from eight pounds of food taken in twenty four hours, five are diſſipated by tranſpiration, and only three paſs off by urine and the excrements. In this it agrees with thoſe of the preceding authors which belong to the hot ſeaſon. In the exceſs

of the perſpiration over the ſenſible excrements. Arbuthnot has confirmed them in the ſummer in England. Linings, who repeated them in South Carolina, likewiſe found that in ſummer the quantity of the perſpiration exceeded that of the ſenſible excrements. Many moderns have queſtioned the reſults of Sanctorius, and have thought that they were manifeſtly carried too high. Haller concludes, from all the experiments made by the different philoſophers who have been quoted, compared with each other, that it is doubtful whether the perſpiration exceed in quantity that of the urine, if we take the average of all the reſults which they have obtained; and that they all differ eſpecially from thoſe of Sanctorius by much ſmaller quantities.

6. We ſhall ſee by the reſults which we owe to the laſt experiments of Lavoiſier and Seguin, that they have frequently obſerved phenomena analogous to thoſe already indicated: but that they have alſo ſeen ſome that are new and different. The following are the inferences which they have obtained from their reſearches.

a. Every four and twenty hours the body returns to the ſame weight when the ſubject is in health and when he is not in the progreſs of growing fat.

b. Bad digeſtion retards perſpiration. He increaſes in weight during four days; and on the fifth he generally returns to the primitive weight

weight. Sometimes the equilibrium is re-eſtabliſhed rather by the augmentation of the excrements than by that of the perſpiration.

c. Drink only, and not the ſolid aliments, increaſes perſpiration.

d. The perſpiration is at it its *minimium* during meals and immediately after them: it attains its *maximium* during digeſtion.

e. The maximum is 32 grains a minute, or 25 hectogrammes in twenty four hours; the minimum is 11 grains a minute.

f. The perſpiration is in the compound ratio of the force of the exhaling veſſels and of the diſſolvent quality of the air.

g. The pulmonary perſpiration is more conſiderable, relatively to the ſurface of the lungs than the cutaneous perſpiration is in proportion to the ſurface of the ſkin. It is ſtill more conſiderable in the winter, on account of the neceſſity of keeping up the temperature of the body at thirty two centigrade degrees.

7. Though the proportion of the perſpiration is one of the moſt important objects to Phyſiology and medicine, there is a ſecond which is alſo of importance and belongs more to the province of Chemiſtry; namely, the knowledge of the matter which iſſues in this manner out of the pores of the ſkin. But few reſearches have hitherto been made upon this ſubject. and it is one of thoſe with which Phyſiologiſts have leaſt occupied themſelves. Haller

Haller confidered as the materials of this evacuation the water reduced into vapour which is frequently vifible. Tachenius was the firft who collected it, by inclofing his arm in an oiled cloth; but he has not examined its nature. Bonnet, Bellini, Winflow convinced themfelves of its emiffion. Lifter by keeping his arm plunged in a cold glafs; obtained a faline water from it. Kaw and Gorter have efpecially infifted upon the water which the contact of the fkin depofits upon the furface of Glafs, and have remarked that the air fpeedily diffolves it. To this firft fubftance, this vaporized water accompanied with fome falts, Haller added the electric matter, the ejection of which he thought to prove by the fparks, the fmell, the decrepitation, which have fo often been obferved in the cloaths at the moment when they have been taken from the body, and in the frictions applied to the hairs of cats; but it is evident that he has confounded the electric effects produced by friction with a pretended electric emanation which nothing proves to take place. The fame phyfiologift alfo ranked amongft the elements of the perfpiration:

a. Fetid volatile parts which he faid were the moft denfe and to which he attributed the traces followed by the venatory animals.

b. Particles of drink and aliment, proved by the fmell. On this occafion he refers to the refult obtained by G. Rye; namely, that from two

two pounds and four ounces of aliment, only four ounces paſſed off by the excrements and two pounds by the ſkin.

8. The new chemical data and a more profound examination of the perſpiration have led to the diſcovery of ſomething more in it than what had been admitted by the illuſtrious Haller. It is not true that there paſs off through the ſkin, as ſome moderns have thought, elaſtic fluids and eſpecially carbonic acid gas; but there is reaſon to believe that at the ſurface the neareſt to the ſkin, namely in its immediate cavities there is diſengaged and burned a portion of carbon; perhaps even a certain quantity of carbonated hidrogen exhales through its pores and experiences a ſlow combuſtion. This we ſhould eſpecially be led to believe by obſerving that the ſkin, expoſed immediately to the air, and not covered with clothes, aſſumes a fawn or brown colour which ſeems to announce the fixation of a greater quantity of carbon; perhaps even it is this phenomenon in a highly exalted ſtate with the negroes, which colours their mucous texture and the interior ſurface of their epidermis. It is known that they are not born with this colour, but that it is formed, or at leaſt grows conſiderably darker by the progreſs of life.

There is no doubt that water ready formed paſſes off through the ſkin and that it conſtitutes the greater part of the perſpiratory vapour. Citizen Berthollet has ſometimes found an acid in

in it, and he has even difcovered in it the phofphoric acid. If this acid were difcharged regularly and conftantly, it muft neceffarily accumulate upon the fkin, for it is not volatile even with the aid of the vaporized water.

9. The matter of the fweat has been thought to be analogous to that of perfpiration; and it has been believed that it differed from it only in not paffing off in the form of vapour, and diffolving in the air much more flowly; and though fome phyfiologifts have imagined the fweat to be a different fubftance and even to have its particular organs, we muft however admit an identity of nature between thefe two excrementitious humours. It is known that the fweat is a faline water, a little vifcous, in which Lewenhoeck had defcribed globules, and which has been little fubjected to analyfis; but which Raymond, Bohnius, Lifter, and Tachenius have thought to be fimilar to urine. According to fome experiments, Petit has found it to be alkaline and turning the colour of violets green. Frequently it has a four fmell and turns blue paper red. It has been known to ftain the linen yellow, green, blue, or black; it is known that it has very various odours, but in general acrid and difagreeable; that it fometimes partakes of that of the aliments; that it is highly odorous and even fetid in animals in heat; that it is fometimes accompanied with fat, with blood, or with bile; that it thickens upon the fkin, and leaves upon it a kind of yellowifh or brown

refiduum;

residuum; that it sometimes deposits sandy concretions, or saline crystals which Haller asserts he has seen upon the skin of glass-makers; that it forms upon the skin of the horse a concrete white or yellowish stratum, which Citizen Vauquelin and myself have ascertained to be real phosphate of lime, detached and separated in small scales by the action of the curry-comb; that its quantity varies extremely from some decigrammes only to a kilogramme and a half. Cardan reckoned the quantity of sweat discharged by a patient under a course of mercury at four kilogrammes and a quarter. Continued sweat is always a severe disease, on account of the loss of substance and the debility which it occasions. It is no longer believed with Lewenhoeck that fifteen small drops of insensible perspiration form one drop of sweat, but it is believed that the sweat is the product of the accumulation of the molecules of perspiration which the air cannot carry off.

10. All anatomists now agree with respect to the organs which exhale the perspiration. They think that it issues from the extremities of excessively numerous minute arteries which open under the skin, and which, on account of their extreme tenuity, suffer only the lightest part of the liquid which they contain to pass. They are convinced that it is not from the lymphatic vessels that it proceeds, but that the function of these is opposite to that of exhalation. It will however be observed that since Haller and the physiologists

physiologists who have followed him, in admitting that the perspiration proceeds from the cutaneous arterial extremities, suppose that these small arteries convey only a white and aqueous liquid; they actually admit a second order of vessels which terminate the arteries, and which are the real white vessels of Boerhaave. For the rest, injections violently passed through the arterial cavities, sometimes, though with difficulty, pass out through the cutaneous pores, or diffuse themselves under the epidermis; so that if these injected liquids were sufficiently attenuated, sufficiently hot, and continually pushed forward, they would actually give rise to an artificial perspiration.

11. A kind of consideration which has hitherto been almost foreign to physiologists, which had almost entirely escaped the sagacity of Sanctorius, of which the illustrious Haller himself absolutely says nothing in the long details which he gives concerning the perspiration, which Kauw, in his work upon perspiration has also passed over in silence, and which modern chemistry alone has almost totally drawn into notice, is the influence of the air in the exercise of this function. It is such that perspiration cannot take place without its contact, that it contributes to it in an immediate manner, that it determines its proportion, that it augments it, diminishes it, raises it to its maximum or depresses it to its minimum, that we ought to affirm at present, as Lavoisier and Seguin

firſt ſhowed with perſpicuity, that the perſpiration is in the compound ratio of the velocity communicated to the tranſpiring fluid by the veſſels which convey it to the ſkin, and of the power with which the air diſſolves it. We recognize the exiſtence of this ſolvent property of the air, when we conſider with attention what paſſes at the extremity of the fingers; we there ſee, eſpecially in the ſummer, ſmall liquid drops iſſuing out of the pores ſituated at the bottom of the elliptrical groves with which this region is ſtreaked, which are ſoon diſſipated in the air and continually renewed, in order to be afterwards taken up and evaporated by the air. The ſteam riſing out of the lungs, from the head, from the hands when taken out of bed, and which we ſee elevate itſelf in torrents into the atmoſphere, is only the tranſition of the liquid perſpiration to the ſtate of elaſtic fluid which the air ſoon gives it; it is neceſſary therefore, in order that perſpiration ſhall take place, that the air ſhould diſſolve it in proportion as it iſſues out of the cutaneous pores. This ſolution is accompanied with a refrigeration which every one experiences, and which moderates the heat to which the body is raiſed under certain circumſtances.

12. It muſt be very evident, according to this exact notion, that ſuppoſing the conditions of the perſpiration to be the ſame with reſpect to the body which perſpires, to the temperature, to the motion of the reſpiration and of the blood,

blood, and to the quantity of perſpirable matter, if the ſolvent quality of the air ſhould happen to vary, variations muſt alſo enſue in the exerciſe of this function. This datum may not only greatly contribute to elucidate the obſervations of Sanctorius, of Keil, of Gorter, of G. Rye, &c. but it muſt alſo introduce important modifications into the notions that have been promulgated reſpecting perſpiration: it may even change a part of the notions that have till the preſent time been conſidered as exact, and in this point of view change the aſpect of the healing art. There is wanting in this reſpect a ſeries of experiments which it is very neceſſary to attempt at the preſent moment; but notwithſtanding this chaſm there are ſome certain principles which are capable of throwing a new light upon the cauſe and nature of diſeaſes, which eſpecially may deſtroy erroneous opinions which have long prevailed. It is evident, after what has been ſaid, that if the air be little charged with moiſture, if it be of a temperature raiſed a little above 15 degrees, for example, if it be frequently renewed at the ſurface of the ſkin by its agitation or its currents, it then combines all the conditions requiſite to its diſſolvent quality; it muſt then take up much water from the ſkin, and the perſpiration muſt be the moſt accelerated and the moſt abundant poſſible. If, on the contrary, the air be hot and moiſt, if it be charged with water to ſuch a degree as to precipitate a part of it, it can take up little or nothing

nothing from the ſkin and the perſpiration muſt be conſiderably diminiſhed or completely ſtopped. This phenomenon frequently takes place in the ſummer, and if it ſucceeds the preceding, the ſkin, which no longer loſes any thing, becomes covered with ſweat, grows ſoft, and the body becomes more heavy.

13. It follows from theſe firſt principles, that when the air in winter, though very low in its temperature, at 10 or 15 deg.—0, is extremely dry, denſe, and agitated; in proportion as it touches the ſkin, it takes from it much caloric, becomes heated at its ſurface, and becomes a ſolvent of water doubly active, both on account of its dry ſtate and of its elevation of temperature; it therefore carries away the more perſpiration the more frequently it is renovated, the more ſwiftly it is moved. Accordingly, in a cold, dry and windy winter, this very highly diſſolvent ſtate of the air, which is perceptible even by the manner in which it evaporates and dries the earth, pavements, and ſurfaces of buildings, vaporizes and carries away ſo much water from the ſkin that it dries, cracks, and riſes in ſcales; that the body ſuffers a great waſte of ſubſtance; that on account of the neceſſity of reparation, the digeſtive powers increaſe rapidly in robuſt and healthy ſubjects; that the urine becomes thick and turbid; that the humours thicken and become viſcous, and diſpoſed to inflammation. Such is the ſource of catarrhs, defluxions from the lungs, pleuriſies, inflammatory

inflammatory fevers, proceeding, as we fee, from the fluggifhnefs, thicknefs, and vifcidity which the liquids have contracted, much more than from a fuppreffed perfpiration, as has hitherto been fo generally believed. From what has been faid, we may conclude, that in dry and windy cold weather, the perfpiration is the moft abundant poffible; that it fenfibly exceeds that of the fummer; and amongft the experiments that have been quoted, efpecially thofe of G. Rye, Robinfon, and Gorter, we find, when we read them with attention, refults favourable to the opinion which I have advanced.

14. We alfo fee, according to this theory, which is founded upon well demonftrated facts, and upon notions more precife than thofe which have hitherto been followed, that the contact of cold water covering the fkin muft prevent the perfpiration; that the bath cannot augment or maintain it, or even let any part of it fubfift, except in fo far as by its more or lefs elevated temperature, it augments the pulfations of the heart, and the force which impels the liquids toward the furface of the body; that frequently it would be either entirely checked or very much diminifhed in fubjects immerfed in a lukewarm or cold bath, or if the portion of their body which is out of the water, if the pulmonary furface did not perfpire in an increafing proportion; that their body would be very much augmented in weight, if a more abundant

abundant excretion of urine did not replace the water retained at the furface of the wet fkin. We thus fee why a covering of waxed filk applied over any part of the body becomes filled with water, and foon ftops the perfpiration. We alfo underftand the utility of ventilation, which diminifhes the heat and the fweat by renewing the folvent air around the body. We conceive that perfons wrapped up in blankets muft have a moift fkin, without on that account really tranfpiring, becaufe they want the contact of the air, the indifpenfable agent of tranfpiration; and when phyficians advife confinement to a warm bed, and the application of blankets, in order to make patients fweat, the good which they thereby procure them is almoft always the retention of the perfpiratory water which the air would have carried away from them, much rather than the difcharge of a larger quantity of this liquid. There is even reafon to think that this mode of treatment matures catarrhs only by actually retaining the water in the body, and thus favouring the dilution of the thickened portions of liquids, and their more eafy feparation from the fides of the canals to which they were in a manner attached by their glutinous and tenacious thickening. It is fufficient to have announced the bafes of thefe new truths, in order to fhow what productive applications they are fufceptible for the knowledge of the caufes of feveral difeafes, and the inveftigation of the means of

combating

combating them, fupported by direct experiments. They will become one of the bafes of the new monument which chemiftry muft foon raife for the art of healing.

15. Phyficians have long obferved a remarkable analogy and ftriking relation between the urine and the perfpiration; they have obferved that the one of thefe evacuations frequently fupplies the place of the other, and that they are conftantly in an equilibrium which is always maintained when the body is healthy and vigorous. In fact, when the perfpiration is diminifhed or fuppreffed, efpecially by the non-diffolvent or little diffolving ftate of the air, the urine is difcharged in greater abundance, and it feems as if there were a direct paffage open between the cutaneous pores and the tubes of the kidneys. Some anatomifts even admit, on account of the rapidity and magnitude of this effect, another paffage than that of the kidneys for conducting the humour of the perfpiration into the bladder. Some moderns think that this function is performed by the fyftem of abforbent or lymphatic veffels, without however having yet proved their immediate communication between the fkin and the bladder. But this is not the point of view under which I ought here to confider the analyfis of thefe two evacuations; the nature alone of the liquids which form them muft efpecially form the object of my attention. I have already remarked, that fome phyfiologifts have found a real

real identity between the matter of perſpiration and that of the urine, and that the ſole difference which they have announced between them conſiſts in the greater quantity of water which the firſt conveys, and the leſs degree of ſaline acrimony which characterizes it. I muſt here add, that ſome of our recent experiments confirm this idea, and that Citizen Vauquelin and myſelf, after having diſcovered a particular urinary matter, which I ſhall deſcribe elſewhere by the name of *urée*, exiſting conſtantly in all the urines of the different animals which we we have been hitherto able to examine, have found it again in the reſiduum of the tranſpiration of the horſe after the evaporation of this humour. I ſhall alſo obſerve, that Citizen Berthollet has indicated a tranſpiration which is acid like the urine, and conſequently that chemiſtry has the means of determining this analogy which has been announced ſo long ago by the experience of phyſicians.

16. In deſcribing the different uſes of the tranſpiration, phyſiologiſts enumerate the ſoftening of the ſkin and of the epidermis, as alſo an excrementitious evacuation which carries out of the body matters, the abundance and acrimony of which might be equally prejudicial; they ſupport the latter opinion by the origin of numerous diſeaſes, which are generally attributed to diminiſhed, retained, repelled, or ſuppreſſed tranſpiration. Galen, after Aſclepiades, has ſtrongly inſiſted upon this uſe of

tranſpiration, which we find was adopted in the ancient Grecian ſchools of medicine. Sanctorius has carried it ſo far as to pretend that as long as this function is in its regular ſtate, no diſeaſe is to be apprehended. Many phyſicians have believed that the diminution of the perſpiration in old perſons was the real cauſe of the gout, and the rheumatic affections ſo common at that age.

Some philoſophers, however, have called in queſtion this uſe of the tranſpiration; they have aſſerted that this evacuation might be diminiſhed, or even ſuppreſſed without injury to the individual: they have quoted the example of nations who cover their ſkins with greaſe and oil, and who, inſtead of ſuffering from this covering which intercepts the perſpiration, find in it the means of augmenting their ſtrength. Bacon even ſuggeſted that this artificial occluſion of the pores of the ſkin might be a means of preſerving life, and retarding the effects of old age. It is true that where they quote the pretended ſuppreſſion of the perſpiration during the winter, without the production of diſeaſe, the advocates for this opinion have committed a great error, as it appears, on the contrary, that in the caſe mentioned (No. 13), this evacuation is very conſiderable. There is reaſon to believe, that in the inſtances quoted by theſe authors, other excretions of the urine, of the pulmonary tranſpiration, and that of the internal cavities, increaſe in proportion as

as that of the ſkin diminiſhes, and ſupply its place.

17. Modern philoſophers have added ſeveral new notions concerning the uſes of the perſpiration, by repreſenting it as an abundant evaporation of water at the ſurface of the body: they have ſeen in it a means of abſorbing the too great quantity of caloric that diſengages itſelf from it, of regulating its temperature, and maintaining it at a conſtant term; of thus evacuating the exceſs of caloric which develops itſelf, either in the lungs by reſpiration, or in the circulation itſelf by the fixation of the oxigen which appears to be continued in it, and to follow its intimate combination. They therefore conſider this function in uninterrupted relation with the reſpiration, and as the regulator of the animal calefaction: they thus explain how, when this calefaction is augmented by any cauſe, the perſpiration, having ſuddenly become abundant, tends to moderate it, and to reſtore it to its original equilibrium. Perhaps the phenomena of the tranſpiratory function may be carried ſtill farther, and conſidered as the diſcharge of the water which is formed in the courſe of the arteries by a ſlow but continual combuſtion of the hidrogen of the blood by the oxigen abſorbed in reſpiration, as well as that which takes place in the pulmonary veſicles. This water carries away with it a part of the animal ſolids and fluids in the ſtate of vapour; and by thus evacuating the part

part of the organs that is too much anamalized and worn, it contributes as it were, to folicit their renovation. For the reft, thefe ideas deferve to be ftudied and fupported by experiments made with more accuracy, and under the guidance of more enlarged views than thofe which have given celebrity to the names of Sanctorius, Dodart, Keil, B. Robinfon, G. Rye, Linings, Gorter, &c.

18. There continually exudes in the internal cavities of the body, in all the hollow vifcera, in the dura mater, in the ventricles of the brain, the pleura, the mediaftinum, the pericardium, the peritoneum, &c. a humour which lubricates their furfaces, which the phyfiologifts have reprefented as a humid vapour, an internal *halitus*, a fort of internal tranfpiration, the exiftence of which has been proved by numerous obfervations. Haller has made exprefs mention of it in his great work on phyfiology. Borden confidered it as a ftream of vapour which ran through not only the internal membranous cavities, but alfo all the cells of the mufcular texture, and he reprefented the body to himfelf as confifting of cellular balls, all open and all communicating the one with the other, only contract from fpace to fpace. But thefe ideas, which were ingenious in their time, muft be modified by the knowledge of the lymphatic or abforbent fyftem, and the humour of which I here fpeak muft not be confounded with that which fills the abforbent veffels, and

 which

which always follows in them a determined courfe.

19. The humour of the interior cavities exudes from the extremities of the arteries, as is proved by injections, and neverthelefs it differs from that which is exhaled by the fkin; it is much lefs aqueous and charged with more fixed matters than the latter. We fhall well comprehend the caufe of this difference, when we confider that the perfpiration is formed only of the fubftance which is capable of being volatilized and diffolved in the air, whereas the humour of the interior cavities is neither a vapour nor a gafeous folution, but a liquid which runs by the effect of the circulation and of the motion of the blood. In proportion as it thus exudes from the internal furface of the membranes which it moiftens, it is re-abforbed by the orifices of the abforbent veffels, fo that it never accumulates to fuch a degree as to diftend thefe membranes; it always forms in them only a light mucous covering which feparates from it and lubricates their furfaces, whilft the animal is in health and vigour.

20. We may diftinguifh the vifcous, mucilaginous, gluey ftate of this liquid, by introducing the finger into thefe internal cavities and upon the membranous furfaces, either of living or of dead animals. We perceive, by the mere fenfe of touch, that this humour is really an albuminous and gelatinous folution analogous to ferum. It is only by thefe fimple experiments that we can

eftimate

eſtimate its nature; for it is not ſufficiently abundant in the natural and healthy ſtate to be capable of being collected and examined by chemical proceſſes. Sometimes however it happens, that this lubricating ſerum accumulates in the viſceral cavities; this takes place whenever the function of the ſyſtem of abſorbent veſſels is languid, or when its energy is not ſufficient for taking up again by ſuction the quantity of liquid which iſſues from the arterial extremities. Dropſy then exiſts, and the liquid which conſtitutes it, when extracted by the puncture, becomes ſufficiently abundant to be ſubjected to analyſis; ſo that we are then able to aſcertain the nature of the internal humour.

21. Rouelle the younger was the firſt who examined what is called the *hydropic water.* That of the aſcites, which he employed, afforded him all the characters of the ſerum of the blood. I have made the analyſis of this liquid, extracted in different ſpecies of dropſies, of the breaſt, of the pericardium, of the ovarium, in the aſcites, and I have conſtantly found in it the ſame characters. This liquid is generally viſcous, gluey, yellowiſh, of a ſweetiſh and ſomewhat ſaline taſte, charged with flakes more or leſs abundant and voluminous, of a yellowiſh-grey colour. It is coagulated by fire, by the acids, by alcohol; it is precipitated by the calcareous and metallic ſalts; it turns the ſyrup of violets green: the flakes which ſwim in it are coagulated albumen; though

though generally fresh and unaltered in the hydropic cavities, it quickly putrefies by the contact of the air. When it is heated, it affords coagulated, porous, light masses, of a sulphur-yellow colour, and tremulous consistence; there remains a slightly yellowish liquid which does not coagulate. When diluted with water and heated, it forms a milky not coagulable liquid; it affords at its surface, by the progress of the action of the fire, a thick yellow pellicle like milk. Boiling water attacks and dissolves the matter that has been coagulated by the fire, so that it then presents the appearance of a gelatinous substance. However, we can obtain no real jelly from this liquor, though strongly evaporated and afterwards cooled; pellicles are separated from its surface from the beginning to the end and during the whole course of this evaporation. The albuminous matter therefore does not exist in it in the real state of gelatin.

22. Sulphur and phosphates are also exhibited by different processes in the hydropic liquor. The first is perceptible by the fetid smell which this liquor exhales when coagulated, by the colour which its vapour imparts to silver, by the sulphuric acid which is formed in it by the oxigenated muriatic acid, and which is discovered by the aid of the muriate of barites. As to the phosphates, lime-water, the solutions of barites and strontian, poured into the hydropic water, produce in it precipitates,

tates, which are eafily difcovered to be phofphates, on account of their infolubility and the manner in which they comport themfelves under the action of fire. The nitric folution of mercury forms in it alfo a flefh-coloured precipitate. The coat of the hydropic water, evaporated to drynefs and burned in a crucible, affords fome traces of calcareous phofphates, but lefs abundant than almoft all the coats of other animal matters. It is ufelefs to add, that the coagulum afforded by this water when heated, affords in diftillation the fame products as thofe of which I have fpoken in the hiftory of the ferum.

23. We muft not confound with the water of the internal furfaces of the membranes the ropy and mucous liquid which lines the fides of the hollow vifcera, of the canals communicating with the external part of the body, opening into the air, and immerfing themfelves into the interior part of the animal cavities, fuch as the oefophagus, the trachea, the inteftines, the urethra, the vagina, &c. The mucus deftined to lubricate thefe parts and to prevent their drynefs and rigidity, is of a different nature from the matter of the tranfpiration, though, like it, it iffues from the furface of the delicate and thin portion of the epidermis which invefts thofe canals, and which is called epithelium. Inftead of being evaporable like the tranfpiration, it contains a kind of gelatinous albumen, little fufceptible of deficcation, rather delique-

deliquefcent, which the air thickens only with difficulty, and which preferves the pliability, foftnefs, and mobility of the fides of the canals where it is depofited. It feems to be of a compofition entirely oppofite to that of the tranfpiratory humour, no lefs fufceptible of preferving its vifcofity, its foft and as it were unctuous confiftence, than the other is of becoming volatilized and diffolved in the air. Accordingly, it performs an entirely different office, fince it maintains the foftnefs and heat of the furfaces, whilft the other tends to dry and cool them.

Article VI.

Of the Synovia.

1. THE Synovia is an unctuous humour, deftined to lubricate the articular cavities, and to facilitate the motions of the heads of the bones upon each other. Clopthon-Havers was the firft anatomift who defcribed particular glands fituated in the articulations as the fource of this humour; but fome modern phyfiologifts now doubt whether fuch be the true origin of the Synovia. The following are the arguments which Xavier Bichat principally adduces, in a very good differtation upon the membrane,

membrane, which includes this liquor, publiſhed in the ſecond volume of the Memoirs of the Medical Society of Emulation at Paris. All the articulations do not contain the pretended ſynovial glands deſcribed by Clopthon-Havers. The mucous capſules of the tendons which facilitate the ſliding of theſe parts by the preſence of the ſame humour which their cavity contains, have not generally glands of this nature. Thoſe bodies, which were taken for glands by Clopthon-Havers, are only cellular texture ſuſtaining blood-veſſels collected into reddiſh balls; they are unfolded into floating membranes; they do not tumefy nor harden as the real glands do, and their pretended glandular nature diſappears under the ſcalpel or by other anatomical proceſſes: beſides theſe granulated lumps or cellular balls are found in other places beſides the ſynovial membranes.

2. The ſame anatomiſt does not confine himſelf to combating the opinion of Clopthon-Havers concerning the ſynovial glands and the ſource of the Synovia: he has collected a great number of facts and arguments in order to prove that this humour has another origin and to diſcover whence it proceeds. For this purpoſe he deſcribes with much greater accuracy and preciſion than had been done before him, the membrane into which the Synovia exhales, where it remains contained for ſome time, and is abſorbed ſo as to be perpetually renovated. According to his reſearches, this membrane,

membrane, which he calls *fynovial*, and which is inclofed in all the articulations, is a bag, or kind of fac without orifice, folded together, of the nature of the ferous membrane, analogous to the pleura, to the pericardium, thin, tranfparent, diftinct from the articular capfule, and to the internal face of which it adheres, detaching itfelf from it below the heads of the bones, leaving a portion of thofe bare, paffing over the articular cartilages which it covers, adhering ftrongly to them, folding back upon the inter-articular ligaments and cartilages and the glanduliform balls; fo that the heads of the bones, the articular capfules, and the interior ligaments of the articulations are on the outfide of this fynovial membrane. We may extend and inflate it by blowing from the interior of the articulations at the points where the articular capfules are interrupted. It is this fynovial membrane, contained, as we fee, in the articulations, covering all the interior furfaces, filling their cavity, having a fmooth, polifhed, and fhining furface, upon which the fliding of the articulated bones takes place. Citizen Bichat thinks that it is formed by an intertexture of exhalant and abforbent veffels, the firft conveying the fynovia by exhalation, the fecond taking it up proportionally.

3. Founded upon this ftructure, this anatomift who has given an account of it, after having compared this membrane with thofe which he calls *ferous;* that is to fay, thofe

which occupy and invest the large cavities, cover the viscera, and are sacs without orifice, such as the pleura, the pericardium, the peritoneum, the tunica vaginalis or of the testicles, concludes from this analysis that there constantly issues from the interior surface of this internal capsule of the articulations a gluey and viscous liquid, as well as from those of other serous membranes, and that this humour is what is here termed the *Synovia.* In order to confirm the identity of its nature with that of the lubricating humour of all the other cavities of the serous membranes, he follows its analogies under four general relations: 1. its nature is similar; it is, like it, albuminous, since, like the latter, the Synovia, being of a viscous consistence, is coagulable by fire, by the acids, and by alcohol; which Clopthon-Havers had already remarked; 2, it performs the same functions as the humour of the internal cavities, since, like this, it serves to render its surfaces smooth, and to favour the motion of these internal surfaces; 3, the Synovia presents an equally striking analogy with this humour in the diseases to which it is subject; in fact, we observe its thickening give rise to adhesions between the surfaces of the synovial capsules, as between the pleura, the peritonæum, and the viscera which are contained in them; we also find hydropic accumulations of the Synovia, as we do of the humour of the other membranes; 4, finally, the synovial humour is absorbed

absorbed by lymphatic vessels, and renovated by the continually renewed exsudation in the interior of the synovial membranes or capsules, like the humour of the other internal cavities.

4. However, Citizen Bichat finds a difference between the apparatus of the synovial capsules, as well as the formation of the Synovia, and the structure of the vessels of the ordinary serous membranes. He observes that the absorbent system of the synovial membranes must differ from that of the other absorbents situated in the other parts of the body, since in the leucophlegmatia the sub-cutaneous absorbents are every where obstructed, whereas this obstruction does not take place in the articulations. This observation, however, is not sufficient for establishing a difference between the two systems, and may be explained by the diversity of the layers of the absorbents; for it is known that the superficial or sub-cutaneous absorbents form a system, if not totally independant of the deep-seated lymphatics, at least sufficiently separated from these not to participate always in the same affections with them. I am much more struck with a difference of infinitely more importance between the Synovia and the humour of the internal cavities; namely, that of the quantity and of the physical properties which very eminently distinguish these two liquids from each other. The latter is never sufficiently abundant to run out at the orifice of the membranes, nor thick and stringy,

as

as we find the Synovia: accordingly, when this thickens, it gives rife to anchylofes or folid adhefions of the joints, whereas the humour of the membranous cavities forms only mucous, tenacious and flaxey ligaments.

5. I have already obferved that the Synovia is an unctuous liquid: its vifcofity is fuch, that it was formerly compared to an oil, and almoft to thofe greafy matters which are employed for facilitating the motions of wheel-work. This fingle character, which all anatomifts have afcribed to the Synovia, would be fufficient to diftinguifh it from the humour of the interior cavities, though the expreffion which has been employed for rendering it is altogether improper. It is in fufficient quantity to be collected with eafe at the orifice of the fynovial capfules which contain it in the articulations of large animals; it is either tranfparent or flightly opaque, a little greenifh, of a confiftence analogous to that of white of egg, of a fweetifh and fomewhat faline tafte, of a faint animal fmell, analogous to that of frog's fpawn. Its fpecific gravity is fuperior to that of diftilled water. Phyfiologifts have hitherto given only a very imperfect and very general notion of this liquor. None of them have made a real chymical analyfis of it. Citizen Margueron, apothecary to the Maifon des Invalides in Paris, read to the Academy of Sciences, in June, 1792, a chemical examination of the Synovia, and this is the only inquiry made with any attention that I know. In exhibiting the

the refults of his experiments, I fhall fubjoin fome reflections concerning the neceffity of repeating them and reviewing fome facts which deferve all the attention of the philofopher.

6. Citizen Margueron eafily procured the Synovia of the bullock from a butcher's fhop where feveral were killed every day. This liquor affumes a gelatinous confiftence fome time after having been extracted from the joints, both in the cold and in a mild heat, as well in clofe as in open veffels : it does not long retain this confiftence ; it even foon lofes its firft natural vifcofity, and depofits a ftringy matter ; it prefents fome differences in its analyfis, according to thefe different ftates ; when it is filtrated as foon as it has been extracted from the joints, it neverthelefs preferves all its properties. A thin layer of fynovia expofed to a dry air in a flat veffel, dries into a fcaly net-work, in which two faline matters are obferved ; the one in cubes, which is muriate of foda ; the other efflorefcence and eafily diftinguifhable as carbonate of foda ; the frefh fynovia alfo turns the fyrup of violets green. In a moift air this liquor becomes altered and putrefied ; whilft it lofes its vifcofity, it becomes turbid, exhales a fmell of putrid fifh, affumes a red or brown colour, becomes covered with a pellicle, and leaves a foft and fetid refiduum, from which lime and the alkalis difengage a large quantity of ammonia. Diftilled in the retort, the Synovia afforded Citizen Margueron a very alterable water charged with ammonia ;

ammonia; at laſt, an empyreumatic oil, carbonate of ammonia, and a coal which contained muriate of ſoda, and phoſphate of lime.

7. The Synovia eaſily mixes with cold water, in which it firſt occupies the bottom, but diſſolves in it by agitation. The author obſerves that it gives to water a very remarkable viſcous fluidity, as it is very ſenſible even when we take ſix parts of water to one of this humour. The mixture froths much by agitation: frequently in ebullition, it preſerves its viſcidity, becomes opaque, milky, and exhibits ſome pellicles at the ſides of the veſſel. The author was ſo ſtruck with the conſiſtence communicated to water by the ſynovia, that he aſſerted no animal liquor preſented any thing ſimilar; he thought he had found its cauſe by the action of the acetous acid. The addition of this acid to the mixture of ſynovia and water cauſed it to loſe its viſcoſity, rendered it clear and tranſparent, made it depoſit a maſs of white fibres eaſy to be ſeparated from the liquor, by tubes of glaſs, which carried them away in a ſingle piece. The liquor thus clarified being put to evaporate, afforded him albuminous pellicles and afterwards cryſtals of muriate of ſoda, and of acetite of ſoda in ſtriated priſms. It was undoubtedly from this experiment that Citizen Margueron ſuppoſed albumen to exiſt in the ſynovia in two ſtates; more denſe than in the other animal liquids, and conſequently capable of imparting a greater viſcidity

1 to

to water. I ſhall ſoon ſhow that there is reaſon to believe that this property may depend upon another cauſe which could not even have been ſuſpected in 1792, or at leaſt that it deſerves to be ſtudied under new relations, and with a new intereſt, as it may greatly elucidate both the functions of the ſynovia and the nature of its morbid affections.

8 Citizen Margueron treated the ſynovia with different acids. The concentrated ſulphuric acid, he ſays, produced a flaky precipitate, eaſily ſoluble in the liquor, and which did not deſtroy its viſcidity: the ſame circumſtance is obſerved, with the ſulphureous, nitric, muriatic and acetic acids. Diluted with from 12 to 15 times their weight of water, theſe acids impair the tranſparency of the ſynovia without deſtroying its viſcous conſiſtence; nevertheleſs, when weakened to ſuch a degree as to leave their acidity ſcarcely perſceptible, they cauſe the viſcoſity of this liquor to diſappear, render it clear and tranſparent, and ſeparate from it a ropy matter which may eaſily be obtained inſulated. The acetous acid eſpecially preſented this character, and he employed it for determining in this manner the proportion of the conſtituent principles of the ſynovia. 288 parts of this liquor extracted from the bullock gave him alſo 34 parts of ſtringy ſubſtance, afterwards 13 parts of albumen in pellicles obtained by evaporation, then 5 parts of muriate of ſoda

 and

and 3 of acetite of ſoda; whence he concluded that it conained 233 parts of water.

9. But what moſt deſerves to engage our attention in this chemical inquiry is undoubtedly the nature of the ſtringy matter ſeparated from ſynovia by the addition of the weak acids, upon which Citizen Margueron has made ſome particular experiments. He has juſtly conſidered it as a particular circumſtance which does not preſent itſelf in any other animal liquor, and which conſequently deſerved to be ſtudied with ſome attention. Preſuming, from the properties which this ſubſtance preſented to him, that it could not be real albumen, though he afterwards deſignated in it the reſult of his analyſis as *albumen in a particular ſtate*, he wiſhed to aſcertain whether it might not be compared with the glutinous matter of wheat. He examined it under this new point of view, and he aſſures us that he did not remark any ſenſible difference of colour, taſte, or odour between theſe two fluids; their elaſticity and their adheſion to the fingers were the ſame; boiling water gave the ſame confiſtence to both; the concentrated acids and alkalis diſſolved both equally. However he has obſerved differences between them; the ropy matter of the ſynovia diſſolves by agitation in cold water; this ſolution froths by agitation; the acids and alcohol precipitate it in flakes; caloric produces in it a very white and very rarefied ſcum. Theſe differences appeared to him ſufficiently conſiderable to induce him to

 conclude

conclude from his examination that the ſtringy matter of the ſynovia was albumen in a particular ſtate. We here find a too manifeſt contradiction between the different aſſertions of the author: as he had ſaid ſome lines higher up that if it had been albumen, *the ſame means employed in order to obtain it from any other animal matter* would have preſented it *in a very different ſtate;* not to perceive the uncertainty and embarraſſment in which he found himſelf involved by the properties of this ſingular ſubſtance. Hence, I ſuſpect that this matter may really be very different from albumen, and that it deſerves to be examined anew with the greateſt attention.

10. The ſynovia affords very perceptible precipitates with lime water, as well as with the alkaline ſolutions of barites, of pot-aſh, of ſtrontian, and even with ammonia. The oxalic acid likewiſe produces in it a very ſenſible precipitation: all theſe effects manifeſtly proceed from the phoſphate of lime which it contains. Citizen Margueron found very ſenſible traces of ſalt in its coal; but he has neither determined its proportions nor diſcovered the mode of its ſolution in this liquor, in which however there is reaſon to believe that it is capable of performing an important function. The carbonates of pot-aſh and of ſoda unite very well with the ſynovia, without producing any change in its viſcidity; the cauſtic alkalis in ſufficient quantity render it more fluid, and even diſſolve

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the ſynovia that has been dried by the contact of the air. This laſt mentioned character of the ſolubility of the ſynovia, when thickened by ſpontaneous evaporation in alkaline liquors, ſeems to announce in an incontrovertible manner the albuminous nature of this humour: however, we might draw this immediate concluſion; for, beſides the uncertainty in which the author of this analyſis has been involved by his experiments upon the fibrous part of the ſynovia precipitated by the weak acids, it is very evident that matters extraneous to albumen are ſoluble in the cauſtic alkalis. Beſides, the very facility or the complete ſtate of this ſolution that has been well remarked by Citizen Margueron, does not belong, at leaſt in this degree of energy, to albumen, and ſeem to indicate another matter, eſpecially an acid; and we ſhall ſee in one of the ſubſequent articles that there are ſome reaſons to ſuſpect the preſence of the uric acid in this particular liquor.

11. Alcohol precipitates the ſynovia without cauſing its viſcidity to diſappear. It ſeparates from it white flakes, inſoluble in the liquid, the nature of which Citizen Margueron has not indicated. The albuminous part of the ſynovia is certainly ſeparated by this re-agent, but muſt be allowed to believe that ſome other ſubſtance is at the ſame time precipitated, according to what the author of this inquiry has remarked. On adding acetous acid to the mixture

mixture of ſynovia and alcohol the viſcidity of this mixture diſappears; there is ſeparated, he ſays, a matter ſimilar to that which he obtained from this liquor treated by the weak acids, and reſpecting the albuminous nature of which there is room for ſome objection, according to what I have already advanced. If this liquor contained uric acid or any of its ſaline combinations, the one or the other would certainly be ſeparated with a portion of albumen; the firſt as being little ſoluble in water or not at all ſoluble in alcohol, the ſecond as being coagulable by this re-agent. It is therefore well proved by this conſideration, as well as by all thoſe which I have detailed in the preceding numbers, that the analyſis of the ſynovia ſtill demands farther reſearches, and promiſes uſeful diſcoveries to ſuch chemiſts as may think fit to occupy themſelves with it.

12. Citizen Margueron had concluded from his analyſis that 288 parts of ſynovia which he had examined as far as to the proportion of its conſtituent materials, contained 34 parts of albumen *in a particular ſtate*, 13 parts of ordinary albumen, 5 parts of muriate of ſoda, 2 parts of carbonate of ſoda, from 1 to 2 parts of phoſphate of lime, and 232 parts, or more than three-fourths of its weight of water. I have explained the reaſons which induce me to think that this liquid contains, inſtead of the firſt of theſe materials, ſome particular animal ſubſtance, of a nature not yet ſuſpected, which

muſt

muſt have a more or leſs conſiderable relation with the diſeaſes which affect this liquor, eſpecially the Anchyloſis, the articular concretions, arthritic tophous humours, &c. Should this latter ſuppoſition be confirmed by new experiments, it will explain the differences which are already known between the humour of the internal membranes or of the interior membranous cavities, and that of the ſynovial capſules; it will prove that notwithſtanding the analogy of ſtructure which exiſts, and which I readily admit, with Citizen Xavier Bichat, between the ſynovial membranes and the other ſerous membranes, nature has intended, with the ſame organic apparatus, to give riſe to different products, and that we are not to infer, notwithſtanding the anatomical reſemblances, that the liquids ſeparated by analogous ſyſtems of organs muſt alſo reſemble each other, till after ſo accurate and ſo careful a chemical analyſis has been made, as to leave no room for doubt or uncertainty.

ARTICLE VII

Of the cellular, membranous, tendinous, aponeurotic, ligamentous, glandular Textures, and of the Gelatin or the Glue which theſe Textures yield.

1. I COMPREHEND under a ſingle article ſix organic animal matters different from each other in their texture, their form, their appearances and their ſtructure, becauſe they are of the ſame chemical compoſition, and afford the ſame products in their analyſis. All theſe different textures are generally diffuſed in the bodies of man and of the other animals. There is not one of their different regions which does not preſent a greater or leſs quantity of them to the ſcalpel of the anatomiſt; ſo that they may be ranked in the claſs of parts that contribute the moſt univerſally to the organization. Each of them has both particular anatomical characters and particular uſes that diſtinguiſh it. The knowledge that has hitherto been acquired concerning their intimate nature and compoſition is undoubtly not ſo much advanced as that of their anatomical ſtructure; it is however ſufficient to approximate them to one another and to oppoſe them collectively in their chemical properties compared together to the other animal

animal matters. Let us caſt a haſty glance upon their ſtructure and characteriſtic differences, and afterwards ſee what they preſent in common with each other, in the phenomena which belong to their decompoſition and to the intimate nature of their conſtituent principles.

2. The cellular texture, which is alſo called *mucous, cribrous texture*, conſiſts of lamellæ, of thin, tranſparent, mucous or gelatiniform plates, of a delicacy which exceeds that of the fineſt gauze, and which may be compared with the light texture which dilated into a ſpherical form by a current of air blown into a ſolution of ſoap. Theſe laminæ are found between the interſticies of all the fibres; they are perceived when we ſeparate them; they connect them together, and at the ſame time ſeparate them from each other; they cannot be well ſeen except at the moment of this ſeparation; finally, they reſemble a gluey form extended upon the parts where they are obſerved. This texture, called the cellular, *tela celluloſa*, becauſe it was believed to conſiſt of cells opening into each other, forming a continued ſeries throughout the whole body, is in fact found in all its parts. It is ſituated under the ſkin in layers, more or leſs dilated by the fat, on the outſide of the muſcles and between their fibres, in the intervals which ſeparate them from the contiguous muſcles, along the blood-veſſels, around and even within all the viſcera. They are not ſmall balls or veſicles communicating freely with each other,

formed

formed of soft and transparent membranes, as Bordeu thought, but reticulations of knotted and lymphatic vessels, supported upon membranous laminæ, and containing a liquid moving in these ducts.

3. I here denominate membranous texture in general those white, thin, tansparent or opaque parts, extended into layers or kinds of tables, frequently folded together, rolled into cylindrical forms, applied in large laminæ, inclosing or covering the viscera, forming sometimes wholly or in part entire organs, existing throughout the whole body, and destined either to contain or to separate and insulate the different parts of the body, having only a white or dull grey aspect, without brilliancy, without silvery surface, and never forming solid cords. Such are especially the dura mater, the pia mater and the arachnoid tunic in the cranium, the pleura and pericardium in the thorax, the peritonæum in the abdomen, the sides of the vessels, especially of the absorbents; the periosteum about the bones, the medullary membrane in their interior, the articular and mucous capsules, the vaginal and albuminous tunics and a multitude of other analogous parts. We might even class under the same head the epidermis and the skin, if these organs did not present certain properties which render it necessary for us to consider them in particular.

Citizen Xavier Bichat has published, in the second volume of the Medical Society of Emulation,

Emulation, of Paris, a very good differtation upon the membranes and their general relations of organization. After having remarked that the anatomifts have not fufficiently generalized the ftructure of thefe important parts, nor diftinguifhed their varied texture, he divides all the membranes of the human body into three claffes: the *mucous*, the *ferous*, and the *fibrous* membranes.

The firft line the interior of the hollow organs which open upon the external furface of the body; folded or doubled into their internal furface, they are lubricated with a mucous juice; they are continuous with the fkin: covered with an epidermis which detaches itfelf in fhreds in fome difeafes, their principal texture is formed of a fpongy tunic which refolves itfelf into cellular texture by diffection, maceration, &c.; they are endowed with fenfibility, and maintain the relations of the interior part of the body with extraneous fubftances, as the fkin does of the exterior; they evacuate by their furface a mucous liquid, conftitute a grand emunctory, have difeafes peculiar to themfelves, fuch as catarrh and polypus, exhale the animal mucus by friction, irritation, and envelop the bodies which remain in them: fuch are the interior of the inteftines, of the vagina, &c.

The *ferous* membranes occupy the large cavities, inveft them, cover the vifcera placed on the outfide of them or in their folds, are facs

without orifices, ſmooth at their internal ſurface and unequal at their external; they are lubricated in their cavity by a ſerum that is diſcharged by exhalation, and ſucked up again by the abſorbents; whereas the thick mucous of the firſt is always like an excretion, after it has been ſeparated by cryptous or mucous glands. They have their particular diſeaſes, eſpecially dropſy, adheſions, peculiar inflammations. They are laminæ or large ſacs which inſulate the viſcera, which may be conſidered as grand reſervoirs in which the lymph is elaborated, which favour the motion of the viſcera. In this order are to be ranked the pleura, the pericardium, the peritonæum, &c.

The *fibrous* membranes, which are leſs numerous than the two preceding, are hard, of a fibrous and white texture, perforated in order to ſuffer the veſſels to paſs through, &c. without folds, thicker than the ſerous, and leſs thick than the mucous membranes, without any liquid that moiſtens them, adhering in all their points, endowed with a particular ſenſibility and tenſion, elaſtic, frequently entering into the organs in which they form a fibrous ſkeleton, and the texture of which they ſupport. It is in this manner that the perioſteum inveſts the bones, the tunica albaginea, the teſticles, &c.

4. The tendinous texture is eaſy to be diſtinguiſhed; brilliant and ſilvery, ſmooth and poliſhed, conſiſtent and tenacious, ſtrongly reſiſting preſſure and extenſion, ſupporting a very heavy

heavy weight before it breaks, formed into a denſe and ſolid cord, rounded or little angular, difficult to be cut, terminating the fleſhy fibres, and ſerving to fix their attachments to the bones, &c. The tendon is the cord, immoveable of itſelf, which, when drawn by the contracted muſcles, cauſes the bones to move one upon the other. It is in ſome reſpect merely a paſſive agent. It is very difficult to cut it acroſs or perpendicularly with the direction of its fibres; it is eaſily ſeparated into faſcia in the direction of their length. It almoſt always ſuppoſes the exiſtence of the muſcles, of which it is a kind of appendage.

5. The aponeuretic texture is a variety of form in the tendon: inſtead of being a hard and ſolid cord, the aponeuroſis is a kind of membrane which covers the fleſhy fibres; which frequently invelops the exterior of the muſcles, to the fibres of which it ſerves as a point of attachment, as a covering which limits their dilatation, as a link which retains their faſcia and their fibres adherent to each other. It is diſtinguiſhed by its fibrous, ſmooth, poliſhed, ſilvery, brilliant ſurface, which ſometimes imitates the luſtre of ſilver. It is an intertexture of flat, hard, cloſe fibres, which have ſeveral different directions, beſides that of the fleſhy fibres which they follow in one of their directions.

6. The ligament, as a particular texture, being ſituated almoſt always between the bones which it

it ties together more or lefs ftrongly, from which function it has derived its name, is found in the vicinity of the articulations, and exifts in them all without diftinction, confequently throughout the whole continuity of the body. It is a compound of grey, folid fibres, very confiftent, very tenacious, very refifting, capable of being pretty confiderably elongated and drawn without breaking, eafily accommodating themfelves to all the motions which the articulations admit, permitting a certain feparation between the bones which form them, oppofing their reciprocal difplacement or luxations; arifing between the laminæ of the offeous texture itfelf by filaments which are implanted there, connecting in the fame manner fome cartilages to the bones, or to each other.

7. Finally, I defignate, by the name of glandular texture, the fibrous parenchyma interpofed between the bundles of lymphatic veffels, the intertexture of which conftitutes the ftructure of the conglobate glands. This has hitherto been faid to be cellular texture, but we need only diffect thefe glands with fome attention, and cut them in different directions, in order to be convinced that this notion is inaccurate. It muft be remarked that I do not confound with the texture of the conglobate or lymphatic glands, which are found throughout the body, the parenchyma of fome large conglomerate glands or glandular vifcera, fuch as the liver, the fpleen, the kidneys, &c.

 Each

Each of thefe vifcera has an intimate nature different the one from the other, as they are of a ftructure peculiar to themfelves.

8. Thefe ten organic textures, without being perfectly of the fame nature, prefent however, in moft of the trials and experiments to which they are fubjected, refults fufficiently fimilar and related with each other, to authorize us to place them together, and to fuppofe in them an analogous general compofition. All of them are infoluble in cold water; and when we leave them to foak or macerate in it for fome time, they become fwelled, dilated, undergo a feparation between their fibres and their laminæ, become foft, mucous, eafy to be torn, incoherent in proportion as they are altered. Moft of them, fermenting with greater or lefs rapidity, when they are moiftened or immerfed in water at a temperature that exceeds 12 degrees of the thermometer, pafs into an acid ftate more or lefs pungent and fenfible to the fmell; fo that we are tempted to confider them as a kind of vinegar. All of them, after the firft period of their fpontaneous decompofition, putrefy rapidly, and produce ammonia, which however is difengaged from them in lefs abundance, and with a lefs fetid odour than is the cafe in other animal fubftances.

9. The fame membranous and white animal matters, when expofed to a conftant mild fire, or to the contact of air at a degree of temperature exceeding 18 or 20 degrees become brittle

and

and tranſparent by drying: they are then unalterable. When they have thus become brittle, and have loſt all their tenacity, however, no other intimate change has taken place in them, except the volatilization of the water which their fibres contained, either ready formed, or compoſed at the very moment of the drying action of the caloric. A ſtronger heat briſkly applied to theſe dried organs cauſes them to ſhrink, to move, to contract in all directions, as we ſee in a violin-ſtring thrown upon burning coals; afterwards they melt, ſwell, inflame with difficulty, diffuſe an odour of little fetidity, and leave a pretty light coal eaſy to be incinerated. When we heat them in the retort, we obtain from them the ordinary products of animal matters, but leſs oil, leſs carbonate of ammonia, leſs fetid gas; in general, they appear the leaſt animalized of the animal compounds.

10. The moſt marked character, or the moſt characteriſtic property which theſe white textures preſent, is that of ſoftening quickly and diſſolving entirely in boiling water, and of forming, when this ſolution is ſufficiently charged, a liquid, viſcous and gluey fluid whilſt it is hot, which concretes into a tranſparent and tremulous jelly by cooling. It is in this manner, and with three or four of theſe textures at a time, that the Flemiſh or Engliſh ſtrong glues, as they are called, are prepared in various manufactories; the Flemiſh, after having cauſed theſe bodies to diſappear entirely, or almoſt

moſt entirely, by keeping them for a ſufficient length of time in boiling water, ſtrain it off clear, and evaporate it to ſuch a degree, that, by cooling, it acquires a perfectly ſolid conſiſtence. The alimentary jellies, which are alſo prepared in the kitchens, the tendereſt and moſt ſavory parts of theſe white textures being choſen for the purpoſe, are of the ſame nature, and differ from the glues only in the choice of the ſubſtance of which they are formed, and by the liquor being leſs thickened and concentrated.

11. We here recognize the ſame ſubſtance as that which has been found in the ſerum of the blood, coagulated by fire, and which diſtinguiſhes itſelf in it from the albuminous part with which it is mixed, by a ſemi-tranſparency, a ſoft and tremulous conſiſtence, and ſolubility in water: this is the gelatin. The properties preſented, when extracted by water, and in the ſtate of jelly, by this ſubſtance, which forms, as we have juſt ſeen, the baſe of the white fibrous or membranous textures, or organs, diſtinguiſh it in an eminent manner from albumen, from fibrin, and from every animal matter; its taſte is weak and faint; it feels mucous and gluey between the fingers, the temperature of which ſoftens it; it melts in the fire, and even becomes liquid at 36 degrees of temperature; it no longer preſerves its original viſcidity, does not adhere to the veſſels, but runs like water: when it has been left to cool,

cool, it concretes into jelly, as before its fuſion, which has not altered it.

12. The gelatin extracted from the white organs, or textures, heated gently and ſlowly in the liquid form which the firſt impreſſion of the fire has given it, thickens, becomes coloured, viſcid, of the conſiſtence of honey, and at laſt aſſumes a concrete, ſolid, and tranſparent form, ſimilar to horn. It is then glue, which is hard, elaſtic, of an orange-yellow, or red colour, brittle, ſoluble in boiling water, and which, in general, acquires the more ſolidity, colour, and glutinous tenacity by its ſolution, as it has been extracted from older or more robuſt animals. When we ſubject it to decompoſition by the fire in a retort, we obtain from it an ammoniacal water, a fetid oil of little thickneſs, zoonate of ammonia and ammoniacal carbonate; it affords little gaſeous product. The coal which it leaves is light, voluminous, and porous; eaſy to be burned, affording neither ſoluble phoſphoric ſalt nor metals, but only phoſphate of lime and muriates of ſoda and pot-aſh. The gelatin becomes ſenſibly acid before it paſſes into putrefaction, and affords ammonia.

13. Cold water diſſolves it, by being continually agitated with it for ſome time; hot water immediately melts it, when its temperature exceeds 25 degrees; and this is the reaſon why jellies cannot be made to aſſume the proper conſiſtence in the ſummer without the ut-

moſt difficulty. When the gelatin has been diſſolved in a large quantity of water, it can no longer become fixed into a jelly by cooling, and it is neceſſary that this too dilute ſolution ſhould be evaporated, in order to reſtore to it this property; it is always made to loſe this property of aſſuming the gelatinous form by refrigeration, in proportion as we multiply the action of the caloric, or expoſe it too many times to the fire. The acids, even the weakeſt, diſſolve the gelatinous matter very eaſily and ſpeedily. The alkalis, likewiſe, poſſeſs this property, but in a leſs marked degree than the acids. The nitric acid diſengages but very little azotic gas from the gelatin, and changes only a very ſmall portion into fat, but the greater part into oxalic acid; the ſolutions of barites, of lime, and of ſtrontian, poured into a ſolution of gelatin, produce in it a precipitate of phoſphate of lime.

14. Several of the properties that have hitherto been deſcribed in the gelatin, and eſpecially its form, its tranſparency in the ſtate of jelly, its aceſcence; the ſmall quantity of ammonia, of oil, and of fetid gaſes, which it affords by the action of fire; the ſmall quantity of azotic gas, and oily ſubſtance which is extracted from it by the nitric acid, which converts a great part of it into oxalic acid; its rare and ſwelled coal, are in favour of the opinion of thoſe who conſidered this matter as having much analogy with the vegetable mucilages, and who believed

lieved it to proceed from the mucous vegetable ſubſtance, that had paſſed almoſt unchanged into the body of the animal. This, however, is a hypotheſis which will appear little probable to thoſe who conſider that the nature of every aliment is changed, from its reception into the ſtomach till its lamellous or fibrous application to the different organic textures which it is deſtined to nouriſh; and beſides, notwithſtanding this analogy between the gelàtin and vegetable mucilage, properly ſo called, there exiſts a real difference which ſhows itſelf in the putrefaction, of which the firſt is ſuſceptible, but not the other.

15. A ſtill greater difference is conſtituted by the manner in which tannin acts upon gelatin, whereas it produces no effect upon the vegetable gummy mucilage: when we pour into a ſolution of animal jelly or glue, water charged with tannin, it produces a precipitate of a fawn-yellow colour, thick, in very fine flakes, which ſuddenly approach each other, and ſoon form a ropy, glutinous, elaſtic maſs, extenſible by agitation, kneading in the moiſt hands, like the gluten of the flower of wheat. This compound of tanned gelatin is dried by the contact of the air, becomes hard, brittle, of a ſmooth texture, brilliant, vitreous, and reſinous in its fracture; it is inſoluble in water, unalterable in the air; it reſiſts many agents and re-agents; it is incorruptible, analogous to ſkins that have been too much tanned, and

 when

when it is rubbed it exhales a ftrong tanny odour; it may be confidered as a pafte, fufceptible of being employed for different ufes, and of which the induftrious arts might avail themfelves with great advantage, if they fhould occupy themfelves with it.

16. Finally, the animal gelatinous matter comports itfelf alfo in a very particular manner with alcohol, which does not diffolve it when it is in the form of jelly extracted by water, but even feparates it from this liquid when its folution is concentrated, which condenfes its fibres or laminæ, when they belong even to the organs, the texture of which they in a great meafure conftitute: fo that thefe organs, immerfed in alcohol, are preferved and condenfed in it, without lofing any thing of their form and ftructure, except a fmall portion of their diameter. This is exemplified in the membranous organs dreffed, diffected, and prepared anatomically, and afterwards fufpended by threads in bottles filled with alcohol: however, this method of preferving them in the anatomical collections has only a certain period of duration, and at laft fuffers an intimate change to take place in their texture, which feparates from it laminæ, foliations and fibres, the precipitation of which we obferve at the bottom of the veffels in which they are contained.

17. Though I confider the fix white organic textures as belonging to a fingle matter, to a fingle gelatinous chemical compound, the dif-

tinguifhing

tinguiſhing character of which is to be inſoluble in cold, but ſoluble in boiling water, ſo as to give riſe to what is called an animal jelly; this notion is, however, not to be underſtood in too rigorous a ſenſe; neither ought we to conſider theſe ſix textures as intirely and perfectly homogeneous. The mere difference of their reſpective form, aſpect, colour, ſtructure, denſity, and tenacity, would ſufficiently contradict this pretended identity. Though the chemical anlayſes, which have not yet been ſufficiently multiplied, have not yet led to a ſufficiently accurate determination of the circumſtances in which the mode of their diverſity, ſo apparent to the anatomiſt and phyſiologiſt, conſiſts; however little advanced this analyſis may as yet be, we may nevertheleſs find in their compariſon and in their reſult, eſpecially when we call to our aſſiſtance thoſe preſented by the arts that are exerciſed upon theſe ſubſtances, a ſeries of facts ſufficiently intereſting to eſtabliſh ſome uſeful diſtinctions between theſe different textures, and to ſatisfy the anatomiſt, who cannot, from his diſſections, be perſuaded of this pretended identity of organs, which to him are really very different. It therefore remains for me to remark the varied modifications of chemical nature between the ſix kinds of textures, which I have hitherto preſented only as being of a ſimilar gelatinous nature.

18. The

18. The very light and froth-like lamellæ of the cellular, or mucous texture, present the gelatinous matter in the pureft, the moft infulated and the moft marked ftate; of this we may convince ourfelves, by the mere confideration of what happens to them by their action in boiling water. Thefe lamellæ diffolve and melt fo completely, that they difappear in the water of thefe decoctions, and all the fibres which they connected together are afterwards found feparated, incoherent, naked, deftitute of the integument which enveloped them on all fides, and the water thus performs a kind of diffection, which is frequently of ufe to the anatomift in his diffections. It is the folution of this texture accompanying the flefh which gives to certain broths the property of concreting into a jelly.

19. The textures of thin white tranfparent membranes, fuch as the pia mater, the arachnoid tunic, the epiploon; thofe of ftronger membranes, as the fubftance of the peritonæum, of the pleura, of the pericardium, part of the tunics of the ftomach and of the inteftines, the periofteum, differ a little from the cellular lamellæ properly fo called; though anatomifts have believed them to be formed of thefe lamellæ united and condenfed, from the circumftance that water does not attack them, except with much greater difficulty and with the aid of a longer fpace of time. In order to diffolve

diffolve them it is neceffary to let them macerate for feveral days in warm water, to feparate the lamellæ and fill their interftices with the aqueous liquid, and afterwards to boil them for a long time in a large quantity of water, and keep them immerfed in it, agitating them inceffantly. We fhould affirm that the gelatin is not fo pure in it, that it is inveloped, as it were, in an infoluble and tenacious fubftance which prevents its fufion. The manufacturers of glue are well aware of this difficulty; the animal matter is fufficiently denfe, fufficiently compact in thefe organs, to dry in the air when thefe membraneous parts are thin and extended, as is exemplified in the art of making cat-gut ftrings. We may alfo combine flowly, particle by particle, the fubftance of this texture with tannin; and at fome future time advantage will be derived from this kind of tanning of membranes or inteftines, by keeping them for fome hours immerfed in a folution of tan, in order to communicate to them a greater folidity and an ufeful inalterability, at the fame time preferving their tenacity and elafticity. For the reft, Chemical analyfis has not exactly determined in what this difference between the membraneous texture properly fo called and the cellular texture confifts; but it is now in progrefs towards determining it.

20. The tendons and the aponeurofes, which are flat tendons, though confifting of folid cords or very tenacious layers, approach more to

to the cellular texture properly ſo called. It is remarked in the boiled meat which is ſerved up at our tables: all its tendinous and aponeurotic parts are melted or ſoftened, when they are well boiled, into a ſort of yellowiſh, tranſparent, gelatinous glue, which ſome perſons prefer, and which in fact has a ſufficiently agreeable taſte. In the preparation of glues, all the tendons are melted and diſappear intirely in the water; they even form the major part of the gluey ſubſtance, and give to water that conſiſtence and viſcidity, from whence jelly is produced by cooling. When the tendons, being drawn out and extended in order to make them preſent a larger ſurface to the air, are dried, they become tranſparent and ſolid, and at the ſame time acquire a yellow or reddiſh colour, as we ſee in dry anatomical preparations.

21. The ligamentous texture, though it alſo contains gelatin which is extracted from it by boiling water, is nevertheleſs of all the white organs that which partakes the leaſt of the gelatinous nature. The familiar and domeſtic fact of the meat boiled in our aliments proves this in a direct manner. At the ſide of a tendon that has been ſoftened and melted into jelly we frequently ſee upon our tables a cord, generally flat and thick, of a white opaque matter, hardly at all ſoftened, and of ſuch tenacity and hardneſs that it is impoſſible for the teeth to attack it, and which cannot be eaten, on account of its exceſſive reſiſtance to maſtica-

maftication. This very remarkable want of folution, at the fide of membranes of the fame flefh, foftened and diffolved in the fame water and in the fame of time, announces not only that the ligamentous texture is much more denfe than that of the other white parts, but that it is probably of another nature; refpecting which chemiftry has not yet decided. The fame is the cafe with the membranous coats of the arteries and veins. Befides the flefhy fibrils and the cellular layers which form a part of them, there is in their texture a matter analogous to the ligament, which refifts the action of boiling water, and is not converted into gelatin like the preceding textures: it is poffible that this matter might be formed by the fibrin; but we have no fact that proves it with the accuracy requifite to authorize us to admit the refult. This texture of the blood-veffels is extremely different from that of the lymphatic veffels: the latter though fufficiently hard and refifting in proportion to its extreme tenuity, neverthelefs melts pretty quickly in water and forms jelly, as we fee in the laminæ of the cellular texture, which modern anatomifts have difcovered to be a tiffue of abforbent veffels.

22. I muft obferve the fame of the texture of the conglobate glands, defignated by anatomifts as bundles of lymphatic veffels folded together and united with each other by cellular texture. Were this its real nature and ftructure, this texture would foften and melt intirely in water, to which

which it would impart the gelatinous character. However, instead of dissolving in this manner, though they do yield a little jelly, the conglobate glands harden and resist the action of a large quantity of boiling water. This resistance is still more considerable in the texture of such of these glands as have acquired a more or less considerable enlargement, and a greater or less degree of induration, in the chronic affections that have been designated in so improper, or at least in so vague a manner, by the name of obstructions, as we find them in persons afflicted with scrophula, &c.

23. Finally, the texture of the skin, which has always been compared with that of the preceding white, soft, and membranous organs in general, and which in fact presents a very striking analogy with them, has however very considerable differences from them; besides which, the important uses for which it is destined, and the remarkable utility which it has in many of the arts, have induced me to treat of it in particular.

24. Neither shall I speak here of the nervous texture diffused throughout the whole body, as it will more naturally require to be considered under the article concerning the brain.

Article VIII.

Of the Muſcular or Fleſhy Texture.

1. THE white, ſoft, and membranous textures in general, which have been deſcribed in the preceding article, form collectively a claſs of organic matters well characterized and well diſtinguiſhed from all others; and by ranking it as the firſt in the order of the general ſolid textures, or of thoſe belonging to the whole body of animals, or which are found diſtinctly in all its regions, I obſerve that we muſt refer to three other claſſes all the different matters which embrace the ſame univerſality of organiſm, or contribute to the general conſtruction of all the organs of animals. I place in the ſecond claſs the muſcular or fleſhy texture, in the third the horny texture, and in the fourth the intirely ſolid or oſſeous texture. The preſent article is deſtined for the hiſtory of the muſcular texture.

2. The muſcles, which in their totality and generality comprehend the fleſhy or muſcular texture, are one of the moſt important and moſt uſeful claſſes of organs in the animated machine; in them and by them it is that the power of life executes the different motions which maintain it, or which inceſſantly ſupply

its

its wants; it is by means of their contraction, of the irritability or the force which produces this contraction, this ſhortening of the fibres which brings together thoſe ſubſtances to which they are attached, that the animal moves, tranſports itſelf in ſpace, ſlowly traverſes the ſurface of the earth, bounds to ſome diſtance from this ſurface, riſes, or ſupports itſelf in the atmoſphere, advances, deſcends, riſes or dives in the water; it is theſe which execute the intermitting and concealed motions which conſtitute life, ſtanding, walking, vaulting, flying, ſwimming, the flexion, the extenſion of the different parts, or the ſenſible action of partial or total locomotion, ſubjected to the will or thoſe paſſions which ſo eminently diſtinguiſh the claſs of organized and animated beings from that of the plants.

3. When we conſider the muſcles in their relations with the other parts of the body of animals, we find in them a new motive of intereſt for ſtudying their properties, becauſe the muſcular ſyſtem forms one of the moſt conſiderable maſſes of the animal organization. Their totality occupies a very large ſpace in the economy of the animal: covered by the ſkin, contained in aponeuroſes, covering on all ſides the bones which they invelop and adorn, it is they that give form and toroſity to the members. Their projecting and protuberant parts, together with the depreſſions of their intervals, diſplay all the forms which the

the ſtatuary and the painter imitate in their moſt finiſhed works, by the aid of which they preſent to our eyes the majeſty of a god in the Apollo, the expreſſion of anguiſh in the Lacoon, invincible ſtrength in Hercules, vigour and dexterity in the wreſtler, the bloom of youth in the Antinous, or grace and beauty in the Venus.

4. The muſcles are ſupplied with liquids by a great number of blood-veſſels, which wind along their ſurface, and enter amongſt their fibres, by lymphatic veſſels which are alſo ſituated round their fibres and in the interſtices which ſeparate them. We find in them nerves which are diſtributed, and loſe themſelves in their faſciæ; cellular texture with which they are abundantly provided, aponeurotic membranes which ſurround them, tendons which terminate them. Though all theſe parts are only acceſſary to their texture properly ſo called, anatomiſts conſider them as belonging to their organization, and in fact they all contribute to their functions: the cellular texture connects their fibres; the blood-veſſels nouriſh and warm them; the abſorbent veſſels take up the ſuperfluity of their nouriſhment, and carry off the parts that are worn by the vital actions; the nerves convey into them the immediate cauſe of their motions, and the order of the will which commands them, of whatever nature this cauſe may be; the tendons determine their action upon ſuch or ſuch parts; the aponeu-

roſes afford a point of ſupport to their faſciæ. There is alſo fat both on the outſide and in the inſide of their fibres, which are thereby enabled to ſlide eaſily upon one another. The totality and the integrity of theſe different textures, which penetrate them and conſtitute them living organs, are neceſſary to the exerciſe of their functions; and when the one or the other is deficient or ſuffers, the muſcle loſes a part or the whole of its activity: on this account ſome of the anatomiſts have ſuppoſed the muſcles to be formed of cellular texture; others have believed them to be conſtituted of nervous filaments; and ſome have conſidered them only as vaſcular extremities.

5. The analyſis of the muſcles provided with all the organic parts which conſtitute their totality is not, therefore, nor can it be, exact, ſince it confounds a great number of different textures together. If it were true that ſuch was the contexture and the compoſition of theſe organs of motion, we could not flatter ourſelves with the hope of being able to aſcertain their nature, except by the analyſis of each of theſe parts; and when once each of them was well known, nothing more would remain to be done in order to determine that of the muſcle. Formerly the analyſis was confined to the diſtilling of the fleſh, and deſignating the quantity of phlegm, of ſpirit, of volatile ſalt, of oil and of coal which it afforded: we muſt add to this ancient notion, that amongſt the

products

products of the flesh we obtain a remarkable quantity of zoonic acid combined with ammonia, and that the muscle appears to be amongst the animal substances that which furnishes the most of this acid. Geoffroy, the physician, has described the effect of water, and quantity of soluble matter which it takes up by ebullition from a great number of different sorts of flesh, with respect to the nutritious matter contained in each of them. This inquiry is of no value, except with respect to the alimentary property. Thouvenel was the first who endeavoured to ascertain the different principles, or rather the constituent materials of the muscles; for this purpose he employed several processes which had not been practised before him, and which enabled him to give a rather more accurate notion of the nature of these organs. I have since occupied myself with the base itself, or with the parenchyma peculiar to the muscles, and consequently with their real texture, independent of all the substances that are only accessary to it.

6. While it is impossible to insulate the muscular texture properly so called from the vascular and nervous textures, from the sanguineous, lymphatic, adipose liquids that are intimately mixed with it, we must content ourselves, in treating of the chemical properties of the muscle, with investigating and separating those which belong to each of those animal matters in particular, and attributing to the muscular

muſcular fleſh thoſe only which do not characterize theſe matters. This method of excluſion may lead, as we ſhall ſoon ſee, to a ſomewhat accurate knowledge of the nature of the fleſhy fibre. Modern chemiſts have treated the muſcle like a vegetable matter mixed with ſeveral different ſubſtances, which they have endeavoured to ſeparate from one another, firſt by mechanical means, afterwards by chemical proceſſes. As the organ is filled with ſanguineous and lymphatic veſſels, which contain liquids, Thouvenel employed the action of the preſs for ſeparating them. The fluids which he obtained were treated ſucceſſively by caloric, which coagulated their albuminous matter, and cauſed their ſalts to cryſtallize by evaporation; and by alcohol, which diſſolved ſome of their ſalts, and a particular extractive ſubſtance, which this chemiſt believed to be peculiar to the muſcles. He made different ſucceſſive applications of water to the reſiduum of the firſt evaporated liquid, in order to ſeparate from it the gelatin and the ſalts; but theſe means did not conduct him to his end ſo exactly as he had hoped; and in fact they preſent great difficulty in the execution.

7. I have ſucceeded better in this analyſis by firſt waſhing the muſcle in cold water, which carries away the blood and the lymph, and which when the fleſh has been cut ſmall and worked with water poured in a ſtream upon its ſurface, ſoon leaves the white muſcular texture

ture infulated, mixed indeed with vafcular tubes, nervous filaments, cellular laminæ of which we may afterwards effect a kind of feparation by the aid of the procefs which I fhall indicate. The water which has wafhed and difcoloured the flefh perfectly refembles blood diluted with water; if we heat it, it coagulates and feparates at its furface in brownifh-red flakes, as happens with the colouring part of the blood; at the fame time there are depofited fibrous filaments, in fmall quantity indeed, but which may be diftinguifhed to be fibrin. The liquor (which is little coloured after this action of the fire, and is flightly turbid and milky) when gently evaporated, affords albuminous pellicles, which are feparated, becomes coloured, acquires a tafte fomewhat acrid when it is concentrated, concretes into a light jelly by cooling, and affords, when evaporated to drynefs, a refiduum of a brown-red colour, from which we obtain, by a well-conducted application of alcohol and water employed fucceffively, a fort of fapid extract of which I fhall foon fpeak, with a fmall quantity of gelatin, and phofphates of a foda and of ammonia.

8. We fee that cold water applied to flefh extracts from it, together with the fanguineous and lymphatic liquor, a fmall portion of extractive and fapid matter, which belongs peculiarly to this organ. When the flefh is thus deprived of what it contained of matter foluble in cold water; if we boil it in water, it ftill fuffers an

albuminous ſubſtance to eſcape, which is collected into greyiſh flakes at the top of the liquor, and alſo a ſubſtance which floats like drops of oil at its ſurface. The fleſhy fibres ſeparate from each other, and the diſſolved lymphatic and cellular texture give the water the property of concreting into a jelly by cooling. A well-managed evaporation of this decoction of fleſh previouſly diſcoloured, ſtill exhibits a portion of ſaponaceous extractive matter, which acquires colour by concentration, with ſome traces of phoſphoric ſalts. The product of this decoction is a kind of bad ſoup, which has not all the properties of that which is prepared with the intire and unwaſhed fleſh, of which we ſhall ſoon ſpeak: however, it differs from it only by its containing fewer principles.

9. After theſe two ſucceſſive actions, firſt of cold water, and afterwards of boiling water upon the muſcles, if each of them has been carried as far as it can go, there remains only a fibrous parenchyma, of a dirty grey colour, and inſipid, which ſo far from diſſolving in hot water becomes hardened by its action; which dries and becomes brittle in dry and hot air, and preſents all the characters of the fibrin of the blood, eſpecially its ſolubility in the weak acids, the property of yielding by the fire much ammoniacal carbonate and a fetid oil; that of affording azotic gas in abundance by the action of the nitric acid, which converts it into yellow fat floating at the ſurface, and oxalic

oxalic acid diffolved in the liquor. I have concluded, from my refearches concerning this flefhy parenchyma, that it is formed immediately by the blood poured fo abundantly by nature into the texture of the mufcle; that the nutrition of this organ confifts in the feparation of the fibrin; that it is undoubtedly on this account, that not only the blood is very abundant in it, but that it is alfo retarded in its courfe before it penetrates into the interior of the fibres, by curvatures and tortuofities; fince, according to the celebrated Haller, a great number of arteries purfue a tortuous and retrograde courfe, before they plunge themfelves deep into the mufcles. It is under this relation that I have reprefented the blood as liquid flefh, according to the expreffion of the Father of medicine.

10. When flefh is boiled in water without previoufly wafhing it, a large portion of the ferous and coloured albuminous matter feparates in brown flakes, coagulated by the action of the heat, and forms the fcum which is taken off; another portion of the fame matter remains adhering to the flefh, and gives it that brownifh fawn colour which, as is generally obferved, becomes darker by the contact of the air: the water gradually diffolves the gelatinous matter belonging to the cellular and lymphatic texture of the mufcles, melts and feparates the fat which fwims at the furface, diffolves both the phofphoric falts, and a par-

 ticular

ticular extractive matter, which gives it the clear yellow colour, the aromatic odour, and the rather pungent and agreeable taſte, which every one knows in fleſh broth. This alimentary liquor, therefore, when well prepared, is a ſolution of gelatinous matter, of an extractive animal ſubſtance, of phoſphate and of muriate of ſoda and of ammonia; it moreover contains a ſmall quantity of fatty oil, diſſolved by the aid of the gelatin and of the extract, a ſmall quantity of albuminous matter, and even a ſmall portion of phoſphate of lime.

11. Fleſh broth preſents to chemical examination a ſeries of phenomena, which prove the preſence of theſe different matters. This liquid is ſuſceptible of turning ſour in hot ſeaſons, on account of the gelatinous matter which it contains; acetous acid is then formed in it. Lime-water, or ammonia, produces in it a ſlight precipitate of phoſphate of lime in a white powder; the oxalic acid ſhows the lime it contains by the white depoſition which it occaſions in it; nitrate of ſilver indicates the preſence of muriatic acid; the nitrate of mercury occaſions a white precipitate, which acquires a roſe-colour by drying in the air, and is a mixture of mercurial phoſphate and muriate, coloured by an animal matter. When we ſlowly evaporate the fleſh broth, it aſſumes an orange and brown-red colour, a ſtronger conſiſtence, and a ſomewhat acrid taſte; and, in this ſtate, it is called (in French) *conſommé*.

Moſt

Moſt of the ſoups reduced to this ſtate congeal, by cooling, into a tremulous jelly; thoſe which are made with the fleſh of young animals preſent it the ſooneſt, on account of the large quantity of gelatin which they contain. By continuing the action of a gentle fire, we obtain, after a more and more decided inſpiſſation, a matter which becomes ſolid by cooling, of a brown-red colour, having a ſtrong and acrid taſte, which keeps for a long time without alteration, which melts intirely in hot water, and forms a ſoup which conſiderably reſembles that which is originally made with the fleſh; this is what is called *extract, or tablets of ſoup*, (portable ſoup) becauſe this ſubſtance is poured into the moulds of tin, in which it aſſumes the form of tablets. If we diſtil this extract of broth, beſides the products common to other animal matters, we obtain a conſiderable quantity of zoonate of ammonia.

12. When the extract, or portable ſoup, is prepared for the uſes of life, and for voyages, the pcoceſs is not confined to making a ſoup of ſimple fleſh. The fleſh of the bullock, the calf, and of poultry, are mixed together; to theſe are added ſavoury vegetables, carrots, onions, cellery, ſome ſpices, eſpecially cloves, with muriate of ſoda in ſufficient quantity, ſo that it actually becomes a mixture of ſeveral different extracts, ſeaſoned with ſaline and aromatic matters, mixed with the portion

of

of faccharine matter contained in the vegetables. Accordingly they have a ftrong tafte, and a lively fmell, different from that of mere boiled meat. The portable foup keeps for a pretty confiderable time. However, it becomes altered after fome years; it becomes covered with a white faline efflorefcence; it attracts humidity, and foftens and becomes mouldy at its furface. The true and pure extract of meat would be neither favoury nor agreeable, in comparifon with that of which I have been fpeaking: it is, however, this extract whofe properties we muft examine, in order to make ourfelves acquainted with one of the principal materials of mufcular flefh.

13. The extractive matter taken up from the mufcle by boiling water, is obtained by lixiviating the product of the foup, evaporated to the confiftence of thick honey, with alcohol: this re-agent attacks neither the gelatin nor the moft of the falts contained in this product. By evaporating this alcohol, which is highly coloured, we obtain a brown-red matter, of a pungent and even acrid tafte, and of a particular aromatic odour; when heated a little more ftrongly than is requifite for drying it, it boils and fwells, and affumes the fmell and faccharine tafte of caramel: it appears that it is this which forms upon roaft meat that brown, fhining, and highly fapid incruftation, which is called the *brown (riffolé)*. This extract remains foft in the air, and gives the portable foup

ſoup its deliqueſcent property. Heated ſtrongly upon a burning coal, it becomes liquefied, ſwells, exhales a white ſmoke, and an acid ſmell. Diſtilled in the retort, it affords water containing zoonic acid and zoonate of ammonia. Its coal contains muriates of ſoda and of pot-aſh; diſſolved in water, it gives it a deep red colour: this ſolution becomes ſour in the air, and partly paſſes into the ſtate of vinegar, depoſiting ſome coal. It ſtill remains to be determined, whether this kind of extract be contained ready formed in the muſcular fleſh, or whether it be not produced by the decompoſition of the fibrous texture, effected by the action of the caloric.

14. The different facts relative to the analyſis of the muſcular texture, which have juſt been enunciated, ſerve to account for what happens to the muſcle, when it is expoſed to the action of different agents in its intire ſtate, and without the different materials having been ſeparated from it. We may thus underſtand, that in the baking or roaſting of meat, the albumen is condenſed, the gelatin melted, the extract dried, the fibrin penetrated with juice is rendered tender, the ſalts are concentrated, and the fleſh, whilſt it aſſumes a brown colour, acquires a taſte and properties very different from thoſe which it has in its crude ſtate. If, inſtead of heating the fleſh ſtrongly enough, and for a ſufficient length of time to bake or roaſt it, we heat it but very ſlightly, and ſo as only to

evaporate

evaporate the water contained in it, it dries, becomes coloured, brittle, and may afterwards be preferved for a long time. The acids foften the mufcle, and diffolve it by acting upon its fibrous part. The concentrated cauftic alkalis alter, melt, and diffolve it, forming ammonia and oil, with which they conftitute a kind of foap. Ammonia produces no perceptible change in it.

15. Many faline fubftances preferve the mufcular flefh, and prevent its putrefaction. Thus mufcular anatomical preparations are immerfed in a folution of alum, in which, however, the flefh is at laft altered and converted into a kind of fat. Fixed oil, the butters, and the fats, with which it may be furrounded, or covered, contribute to preferve it; the volatile oils, the refins, the odorous woods, the bitter and aromatic leaves and barks, act alfo as anti-putrefcent, and prevent the feptic decompofition of this texture. Tannin diffolved in water alfo penetrates its fibres, precipitates in them the gelatinous matter, and furrounds them with a layer of tanned matter, which equally oppofes their putrefaction. Alcohol contracts and condenfes its texture, fo that it cannot afterwards undergo that kind of fpontaneous alteration which tends to deftroy its compofition.

16. The mufcle left expofed to the air, putrefies very quickly, when the temperature of the atmofphere exceeds 15 degrees. Its component parts at firft exhale a faint or mufty fmell; it acquires

acquires a livid colour, which grows darker in proportion as the putrid decompofition advances; its texture foftens and melts at the furface into a kind of liquid putrilage; the fmell becomes fetid, ftrong, and ammoniacal; fometimes there is difengaged at its furface a phofphoric light, which fhines both in water and in the air, and fubfifts for feveral fucceffive days. When the whole of the flefh has been equally foftened, diffolved, and turned green by putrefaction, it at laft leaves, continually exhaling a fetid odour, a brown or blackifh refiduum, which, for a long time, is foft and moift, but dries after feveral months into a kind of animal mould, in which we find fome traces of fat, of carbon, and of alkaline phofphate and muriate. When the mufcular flefh experiences the putrefactive motion, after having been immerfed in water, its decompofition gives rife to another product. There is formed a fatty, white, fufible matter, confiderably refembling what is called *fpermaceti*, and which I have already defignated by the name of *adipocire*. This phenomena takes place fo conftantly, as I firft obferved fourteen years ago, in all the mufcles of the carcafes of animals expofed upon the borders of rivers, brooks, and lakes, that I have propofed its re-production in order to procure, from animal remains that are generally thrown away in the country, and even in large towns, a kind of fat which may be of ufe in feveral of the arts. It was undoubtedly from this

this propofal that Mr. Gibbes has defcribed this new art in the volume of the Royal Society of London, for the year 1797.

17. It ftill belongs to the province of chemiftry to determine the changes which the mufcles experience in different kinds of difeafes which attack their texture, and at the fame time alter their intimate nature or compofition. This art will fhow what happens to them in the diminution of their alterability, in the foftnefs which they fometimes acquire, and which renders them very eafy to be torn, in their acquiring the bright red or light brown colour, which characterizes them in the courfe of other affections, and efpecially in the white colour, and fatty unctuous afpect which they contract in the courfe of long continued paralytic immobility and infenfibility.

18. The difference of the mufcles in the different orders of animals is alfo one of the moft important objects of chemical refearch for the animal philofophy, but unfortunately one of the leaft advanced; for we can fcarcely reckon amongft thefe refearches the firft experiments made more than fixty years ago by Geoffroy upon the nutritive quality of different kinds of flefh compared with each other. The object of chemical analyfis ought to be to refolve the following queftions, the folution of which can be expected from this alone. In what does the mufcular flefh of the mammalia of the chafe, characterized under the name of

black meat or *venifon* by its brown or dark red colour, differ from that of the ordinary mammalia? Are the mufcles of the carnivorous animals different from thofe of the frugivorous? How does the compofition of the flefh of young animals differ from that of the fame animals more advanced in age? Is the white flefh of birds of a different nature from that of the mammalia and from that of the birds with black and odorous flefh, as well as from the oily and hard flefh of water-fowl? What is the comparative nature of the flefh of fifhes, both in the cartilaginous and in the prickly fpecies, of that of the fea and of frefh-water fifhes, of that of the oviparous quadrupeds, of ferpents, of infects, and of the teftacea? All thefe queftions, and many others to which thefe will naturally lead, are adapted to throw the greateft light upon the phenomena of life, of irritability, of the tonic force, &c.

Article IX.

Of the Dermoid Texture, or of the Skin, and of the Epidermoid Texture, or the Epidermis.

1. THE body of the greater number of animals is inveloped, and all its organs are covered by feveral layers of different membranes, which

which are called in general teguments. In man, in whom this cutaneous covering is the moſt perfect and the beſt organized, as it is not only deſtined to contain all the other parts, but alſo to form the ſeat of the ſenſe of touch, which is more or leſs deficient in moſt of the animals; the teguments are compoſed of three membranes or three ſucceſſive layers; the innermoſt, that which is applied immediately upon the fatty cellular texture, is the thickeſt, the ſtrongeſt, the moſt reſiſting: it is the ſkin properly ſo called, or the derma. Above and on the outſide of this firſt tegument is a ſoft, cellular, areolar, mucous layer, formed of a thin net-work, the meſhes of which are filled with a kind of gelatinous texture, in the midſt of which are placed as upon cuſhions, the papillary extremities of the nerves, the ſeat of the touch: this ſecond layer is the reticular texture of Malphighi. Finally, on the outſide of and above this ſecond texture, is applied a fine, tranſparent membrane, dry externally, which covers the nerves, and is known by the name of epidermis. In the animals this laſt covering varies greatly; there is beſides, under the ſkin, a flat muſcle, generally diffuſed over the whole body, which is called the *fleſhy panicula.*

2. Theſe three ſucceſſive teguments differ in the different parts of the body; they are fine and delicate in ſome parts, thicker, and more ſolid in others. The nerves of touch in man are

are more multiplied and of a more elegant, more regular, and more diftinct ftructure at the extremities of the fingers. The derma is in general and in all animals extenfible, perforated with holes which permit the nerves, the hairs, and the extremities of the arteries to pafs through; it varies greatly with refpect to its thicknefs, its elafticity, its tenacity, in the animals of different orders and genera. The reticular and mucous texture is more or lefs foft, denfe, and thick, according to the parts to which it belongs; it has neither the fame organization, nor the fame extent, nor the fame functions in the animals whofe fkin is covered with hairs, feathers, or fcales. It is charged with a black matter in negroes; and when it has been deftroyed by a wound or ulcer, this portion of the fkin remains white in the cicatrix;

The epidermis is an almoft inorganic membrane; it is compofed of laminæ or plates difpofed in fuch a manner that their edges cover each other like the fcales of fifhes. It is tranfparent, and very thin: it is re-produced very eafily and very quickly; its place is fupplied by real hard and horny fcales in fifhes, in ferpents, and in the oviparous quadrupeds.

In general there exifts no organic texture more varied and more different in itfelf than the whole of the integuments in the different orders or genera of animals. It would require a very extenfive anatomical differtation to point out only their principal differences, and thefe

details

details would here be out of place. It may be ſufficient to remark that it is in the diverſity of the ſkin, and eſpecially in that of the extremities and appendages which cover, defend, or arm it, that the principal apparent difference of theſe beings conſiſts, and that this is conſtantly the indication or the ſeat of a more or leſs conſiderable difference in the primitive or interior organs of animals.

3. Inſtead of conſidering all the varied modifications of properties and of ſtructure of the different orders of animals,—modifications concerning which chemiſtry will at ſome future period have as many details and preciſe notions to give as the anatomical deſcriptions furniſh, and which will diffuſe over the arts and the employment of the tegumentous texture in general a light which would in vain be expected from any other ſcience; I ſhall occupy myſelf only with its general compoſition, which preſents more or leſs analogy in all animals. The ſkin of man, and of ſome of the mammalia, will more particularly ſerve me as example; and in treating of the character of ſome other ſkins, I ſhall only endeavour to ſeize their moſt remarkable relations. I ſhall examine more particularly the three different textures of the human ſkin, becauſe it is the moſt complicated in its organization; and I ſhall make it as it were the type to which I ſhall refer the properties of the other ſpecies of cutaneous textures of animals.

4. The

4. The derma, or the ſkin properly ſo called, when well ſeparated from the fat, the cellular laminæ, and the veſſels which adhere to it, as well as from the muſcular fibres with which it is provided in animals, is a thick, hard membrane, capable of being extended, elaſtic, difficult to be cut, preſenting fibres arranged or diſpoſed like the hairs of felt, leaving ſome areolar interſtices between them of a white colour. When it is briſkly heated, it contracts and is agitated; upon burning coals it melts, ſwells, exhales a fetid odour, and is reduced into a coal conſiderably difficult to be burned. It affords by the retort nearly the ſame principles as the fibrous matter, a thick oil, and much carbonate of ammonia. The products are in general very fetid; weak acids ſoften it, ſwell it, give it tranſparency and diſſolve it; the nitric acid diſengages from it much azotic gas and Pruſſic acid, and changes it into fat and oxalic acid: the concentrated cauſtic alkalies diſſolve it, and convert it into ammonia and oil. It is converted by its ſpontaneous decompoſition in water, and in moiſt and fat earth, into adipocirous matter and ammonia, as may be obſerved in burying places. The ſkins of the carcaſes that have been buried for ſeveral years, are found very diſtinct and ſeparate from the ſubjacent parts, preſenting a grey layer, conſiderably greaſy, brittle, and exhibiting all the characters of an ammoniacal ſoap.

5. The

5. The action of water upon the derma is the procefs whereby its nature and compofition are afcertained in the moft accurate manner. The derma, immerfed and kept in cold water, dilates, becomes flightly foftened, fwells, lofes fome of its tenacity, and at length becoming at the fame time thicker, fuffers the hairs which cover it to be pulled out with eafe, after which it becomes femi-tranfparent, and feems to affect the gelatinous nature by this maceration. When the fkin is left for a long time in this fluid, it becomes altered, putrefies, emits a ftrong fetor, becomes like a foft jelly, and affumes an ammoniacal fmell. If, inftead of letting it putrefy in this manner, we boil in it a fufficient quantity of water after it has been fwelled, we fee it melt, diffolve entirely, and form a vifcid, gluey, thick, ropy, and even glairy liquor, which acquires a homogenous confiftence and liquidity when it is boiled for a fufficient length of time. In this manner is formed a real animal mucilage, a jelly which becomes fixed or congealed by refrigeration, and which affords glue by evaporation and concentration. In many of the arts this property is well known and employed with much fuccefs. Different glues are prepared with glove-fkin, eel-fkin, fhreds of the fkins of quadrupeds, of different fifhes, &c. It is eafy by this fingle procefs to find a remarkable difference between the different kinds of fkins. That of

fifhes

fishes melts quickly; that of man and of the mammalia, of the bullock and of the horse, do not dissolve, except with the addition of more water, heat, and time; but all of them, when subjected to a sufficient maceration, at last melt in the water, and pass to the state of jelly or glue.

6. When we observe with great attention what happens in this transition of the dermoid texture into the state of gelatin by ebullition in water, we remark that the skin of the bullock or of the horse, which is very analogous in this respect to the human skin, presents, previous to its melting, fibrous or filamentous flakes which swim in the liquor, and do not dissolve without much difficulty, whilst another portion has been dissolved by the first impression of the boiling water. Hence it has been concluded that the dermoid texture is composed of two principal matters, the gelatin and the fibrin. Citizen Seguin, who has much occupied himself with the analysis of this texture, with a view towards determining the theory and perfecting the art of tanning skins, has formed more mature notions relative to its composition than chemistry before possessed respecting this object. According to him, the cutaneous fibre, being very analogous to the sanguineous or muscular fibrin, is only a kind of oxigenated gelatin, incapable of being combined in its fibrous state with water and the tannin principle: it is necessary to unburn it as it were, or to deprive it of a

 portion

portion of its oxigen, in order to render it susceptible of uniting with the tannin. It appears that a similar disoxigenation takes place in the long and successive action of cold and of boiling water upon the derma, since from having been fibrous and insoluble at first it at last becomes intirely soluble and gelatinous. The effect of the great and speedy solubility of the skins of fishes and of oviparous quadrupeds, and the facility with which they form jelly, as well as the large quantity which they afford, is in favour of this idea of the oxigenated nature of the derma, since it appears to approach the nearer to the gelatinous state as it belongs to animals that respire less, that require less atmospheric oxigen, and whose blood is the least heated.

7. The observations and experiments which Citizen Seguin has made upon tanning, having led him to this theory of the nature of the texture of the skin, it is necessary to give the result of his experiments in this place. The precipitate of glue or of pure gelatin by tannin is brittle, and if the derma were purely gelatinous, tanned skins would be equally brittle. The fibrous texture of the derma does not combine with the tannin; but when we cause it to return to the gelatinous state by taking oxigen from it we render it susceptible of combining it with tannin. This is what is done in the preliminary clearing, softening, and swelling of the skins before they are subjected to the tanning operation

tion. The fibrous part and texture of the derma being of an irritable nature, the action of the weak acids or alkalies causes the small hollow filaments of these fibres to contract and thicken, till, by this action itself, this property is exhausted by the effect of shortening, which diminishes the length, and increases the thickness of the derma. Its gelatinous part is dilated, divided, easy to be dissolved and actually dissolved in the water with which it is soaked; at the same time that its fibrin, dilated and shortened, is unburned by losing a portion of its oxigen. In proportion as it is disoxigenated, it combines with the tannin which is deposited in it: it must not be too much unburned, nor return to the state of pure gelatin; which would render it over-tanned and too brittle: it is on this account that in the swelling, the portion of gelatin which it contains is taken from it. The gallic acid which exists in the tanning water, already exhausted of tannin by the skins, and which is discovered in it by its precipitating the sulphate of iron in the black state, particularly effects this decomposition of the fibrous part of the skin, as we see it effect the disoxigenation of silver, of gold, and of several other metals when we pour it into their solutions: it is on this account that the exhausted tanning water is so useful for the swelling and unhairing of the skins. Finally, the fibrous derma, thus unburned, shortened, irritated and afterwards combined in a semi-gelatinous state with tannin,

having loſt its irritable property and primitive nature, can no longer be ſhortened nor change its dimenſions. However this tanned compound which in good leather is not real tanned gelatin, may ſtill be elongated and flattened, and preſerve a ſort of ductility under the hammer of the ſhoemaker who beats and works it; but it keeps, like the metals, the dimenſions which it has acquired by preſſure.

8. We may therefore draw the following inferences from theſe ingenious obſervations relative to the nature of the derma: that it is in general formed of two textures or two diſtinct matters; the one of which is gelatinous, immediately ſoluble in water and immediately precipitable by tannin: this is extracted from the ordinary ſkins of quadrupeds before they are tanned. The other matter, the true ſolid, extenſible, elaſtic, irritable texture of the ſkin of man, of the mammalia, and of the birds, is the fibrin or oxigenated gelatin; it contains the former in its meſhes; it contracts in one direction and ſwells in its length by the action of the ſaline ſtimuli; it is unburned by the acids, by long expoſure in water, and by ebullition; it returns to the gelatinous or ſemi-gelatinous ſtate according to the proportion of oxigen that is taken from it. It is undoubtedly in the proportion of theſe two matters that the difference of the two kinds of ſkins conſiſts, which is variable according to the nature of the animals, their manner of living, their very high or very low degree of oxigenation, &c.

9. The

9. The reticular texture of Malpighi, or the mucous net-work ſituated immediately upon the ſurface of the derma, and which contains the nervous papillæ deſtined for the perception of the touch, appears to be compoſed of two different ſubſtances ; a ſoft gelatinous covering extended over the whole ſurface of the ſkin and very light, and very fine granulated tubercles, which are nothing elſe than nervous expanſions. Chemical analyſis has not been able to operate upon this texture, as it is ſo fine and delicate, that it cannot be ſeparately detached, and ſeveral anatomiſts have denied its exiſtence, not having been able to diſcern it, even with the aid of ſtrong magnifying glaſſes and microſcopes. It is ſuppoſed that the black colour of the negroes has its ſeat in this texture, and that it depends upon a colouring matter diffuſed in it, becauſe this black ſubſtance may be removed by means of ſolvents without touching the derma and leaving it white, and becauſe the layers of the epidermis when ſkilfully ſeparated are tranſparent and colourleſs. Nothing has yet been done with reſpect to the colouring matter of the ſkin of negroes, neither do we know what is its nature; we know however that it is capable of being diſcoloured and paſſing into a yellow tinge by the contact of the oxigenated muriatic acid. A negro who had placed his foot in a ley of oxigenated muriatic acid, and held it for ſome time in that liquid, preſented the part almoſt diſcoloured and inclining to whiteneſs ; but a black colour

as beautiful and as pure as that which it had before was entirely formed at the end of fome days.

10. The fcaly, dry and tranfparent texture of the epidermis in man proves by its mere afpect, that it differs remarkably from that of the cutis: it is far from being fo diftinct in the animals. When the human fkin is boiled in water, according to the obfervation of Citizen Chaptal, it firft grows tough, and feparates into two diftinct parts: the leather, or the cutis, which contracts, thickens and acquires the confiftence of a foftened cartilage; and the epidermis, which does not diffolve, whereas a continued ebullition changes the cutis into a gelatinous mucilage. Alcohol does not attack the epidermis, even when kept for a long time in digeftion upon this membrane. The cauftic alkaline leys diffolve it with eafe. The fame folution is obtained with lime water; but this folution does not take place unlefs during of a much longer fpace of time than that which the pure alkali requires: this we perceive even in rubbing a cauftic alkaline ley between the fingers; for it affumes an oily confiftence and feel, in proportion as the ley acts upon the epidermis which it diffolves. Citizen Chaptal finds in thofe properties an analogy between the external epidermis of the human body and the matter which covers filk. He obferves that when a fkin, provided with its epidermis, is immerfed into a folution of tannin,

the

the latter only penetrates it on the fleſh ſide, and that the epidermis, which does not combine with this ſubſtance, prevents its paſſing from the ſide of the hair or grain ſide. In the unfleſhing, the epidermis is removed from the ſkin, which then admits the tannin at both its ſurfaces; and the lime, which is generally employed in this operation, acts as a ſolvent of this exterior membrane. Lime-water, on account of the ſmall quantity of the earth which it contains, acts but very little, and requires to be renewed in order to ſeparate this external membrane.

Article X.

Of the Corneous Texture, of the Hairs, and of the Nails or Hoofs.

1. SCARCELY any part of the ſurface of the human body is entirely deſtitute of hairs; indeed they are well marked and in conſiderable quantites only in certain regions, eſpecially the axillæ, the pubes, the linea alba, the front of the breaſt, the region of the ſhoulder blades, the thighs and legs, the back of the hands, part of the face, of the chin, and the upper part of the neck. There are ſome individuals in whom almoſt the whole ſurface of the body is hairy, but theſe are in general

general rare. The palm of the hands, the ſoles of the feet, the red part of the lips, the ſurface of the prepuce and of the glands, and in general all the parts that are covered with the *epithelium*, are the only part which are conſtantly deſtitute of hair. They are diſpoſed in a regular manner in ſome parts, curved into arches in the eye-brows, bent and projecting in the eye-laſhes, rigid and like ſmall pincers in the noſtrils, when they are called *vibices*; erect and in tufts in the concha of the ears, turned in different directions upon the chin, curled and ſhort upon the pubis, the axillæ, &c.

2. The ſkin of the cranium is provided with long hairs very cloſe to each other, deſtined to deſcend over the forehead, the ears, the back of the head and ſhoulders, when they are ſuffered to grow, conſtituting, like the beard, the natural ornament of man, and a defence againſt the rain, the heat of the ſun, inſects, falls and blows, cold, &c. The hairs of the head have not the ſame ſtructure as thoſe of the other parts of the body, though they are of the ſame nature. Much more tufted and ſtraight, they grow to a much more conſiderable length, and their growth has no real limits. Men differ very much from one another with reſpect to the nature of their hairs; and their races are characterized by hairs long and ſtraight, ſhort, curly or criſped, ſoft or rigid, long or ſhort.

3. The colour of the hairs alſo conſtitutes one of the moſt remarkable differences; it

varies

varies in different countries, latitudes, climates, temperatures, ages, and fexes. The human fœtus has them frequently white; they remain fo in cold countries: however, in the moft rigorous climates and towards the poles they are brown. In the fiftieth degree of latitude, according to Haller, red hair was formerly the moft frequent. The hotter the climates are, the more the hair approaches to the black. An exception to this rule are the Albinos, fo called on account of their pale-blue fkin and their milk-white hair. It is generally faid, that cold and phlegmatic temperaments that abound in white juices are characterized by very fair hair; that the choleric temperament produces red hair, and the fanguine black. Whatever be the climate, the hairs conftantly turn white in old men, and become tranfparent by the drynefs of their centre. It is alfo commonly faid that grief turns the hair white, though moft phyfiologifts deny the certainty of this fact. Some difeafes produce this effect. In feveral animals, efpecially hares and rabbits, the hair becomes white in the winter, particularly towards their points. The diameter of the hairs of the head has been eftimated at between $\frac{1}{300}$ and $\frac{1}{700}$ of an inch. Withof counted 572 black hairs in the fpace of an inch, 608 brown, and 790 fair; fo that the latter are reckoned to be the thinneft.

4. The hairs have a very remarkable ftructure, which has been very well defcribed by

ſeveral anatomiſts, eſpecially Malpighi, Ledermuller, Withof, Chirac, and Haller. Under the cutis, and in the midſt of the fat which diſtends the cellular texture, are implanted in this cutaneous fat which appears to be their true ſeat, oval, flat, reddiſh bulbs, formed of a hard, elaſtic, exterior tunic, and ſupplied by ſanguineous veſſels. The interior of this external integument, which is hard and eaſy to be cut into ſmall laminæ, and from which a more or leſs viſcous ſanguineous liquid flows when it is open or punctured, contains a ſmaller bulb, cylindrical, oblong, hard and white. The baſe of the hair is incloſed in this interior bulb; the hair in it is finer, and ſofter than in its exterior part, crooked and conical. It iſſues from the tube covered with two integuments furniſhed by the membrane of both bulbs. When it has arrived at the pore of the ſkin through which it paſſes, it relinquiſhes its exterior covering, and retains only the interior. In paſſing immediately under the epidermis, it raiſes and puſhes before it this membrane, which ſurrounds it, and thus furniſhes it with a ſecond exterior covering. This ſecond tunic adheres ſtrongly to the proper tunic which the hair receives from the interior bulb: it is tranſparent, hard, and corneous. When we cut this epidermoid tunic, we find the interior texture of the hair compoſed of from five to ten filaments connected together by a mucous and gluey texture; this interior and central texture

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of the hair is thick as in the bulb itſelf: it ſhrinks and diſappears by drying.

5. To this ſtructure deſcribed by the anatomiſts, and eſpecially by the illuſtrious Haller, I ſhall add that the exterior covering appears frequently to form ſcales detached from the ſurface of the hair, towards the upper part of each, like ſmall branches diverging from it, and that it is on this account that when we rub a hair between two fingers, it always raiſes itſelf, like the beard of corn, in the direction from its baſe towards its point: ſo that when we paſs this delicate organ between the fingers with a rotatory motion, we may eaſily diſtinguiſh its baſe from its point by the circumſtance that it always moves in the direction of the latter; that is to ſay, it aſcends if the point be placed downwards, and deſcends if it be placed uppermoſt. It is by this ſtructure, which anſwers inſtead of ramifications, and acts as it had very ſhort branches, that Citizen Monge has explained the effect of felting which hairs experience by the mere friction or percuſſion which is applied to them: theſe ſmall filaments become engaged in their reciprocal notches, and are thus ſolidly hooked together by preſſing them cloſe againſt each other. It is alſo evident, according to the ſtructure that has been indicated, that the hairs, viewed by the microſcope, muſt appear like kinds of ſticks tranſparent and ſolid, like ſcales or horn; that when we cut them, and view their horizontal ſection,

fection, or the perpendicular with their axis, they muft exhibit a kind of marrow at their centre; that this central medullary texture, proceeding from the interior bulb, muft, by drying, leave the membranes alone, tranfparent and dry, and give whitenefs to the hairs; that when they begin to dry they muft fplit at their extremities, and that it is on this account that we frequently find them bifurcated. It is alfo evident, that on account of their double covering, and of the medullary and filamentous centre which they contain, the hairs muft poffefs a certain ftrength, and fupport fome weight without breaking.

6. We may alfo confider the hairs as hollow tubes, or ducts, communicating immediately with the cellular texture, capable of pouring into the atmofphere a vaporous liquid, or one fufceptible of diffolving in it, and conftituting a particular emunctory. They are capable of impeding the electric fluid, and of infulating thofe bodies which they cover, as filk does. They poffefs, like many animal textures, the hygrometric property in fo marked a degree, that they are employed for conftructing hygrometers in preference to all others. It is on this account that the hair fo readily lofes its curl by the contact of water, of dew, or of fogs. The hairs dry and fall off in difeafes; their bulbs are frequently deftroyed by depraved ftates, or ulcerations of the cellular texture. They fwell and become painful, though infenfible in their pro-

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per texture, by the effect of the *plica polonica*. Their diameters, being augmented in this affection, permits the blood to flow out by their extremities; and it is upon this principle that we are to account for the drops of blood, or the hæmorrhages, which follow the cutting off the hair in this terrible malady. Finally, the hairs receive ſuch an influence from external bodies, that the perſons who work copper have them coloured green by the oxide of this metal, even in their interior part, and not merely in their external layers.

7. After having deſcribed the ſtructure and the phyſical properties of the hairs, we muſt occupy ourſelves with the examination of their chemical properties. Formerly the analyſis of theſe bodies was attempted by the action of fire: Neuman having treated a pound of hair in the retort, obtained from it five ounces and ſix drachms of urinous ſpirit, two ounces and one drachm of concrete volatile ſalt, three ounces and ſix drachms of oil, four ounces and three drachms of caput mortuum, containing twenty one grains of ſalt. But notwithſtanding this kind of repartition of the products of ſix ounces of diſtilled hairs by Neuman, it is evident that his analyſis was far from being exact, as he intirely neglected the elaſtic fluids which are diſengaged in abundance from diſtilled hairs, and of which he had taken no account; and as he found again the total weight,

weight, it cannot be doubted that he was obliged to suppose the quantity of some of the liquid products, which he alone collected, to be more considerable. We shall see, by the exposition of a more recent analysis, that there are still other errors in that of Neuman.

8. It is to Citizen Berthollet that we owe this second analysis, which is much more exact than that of Neuman, though the French chemist published it in 1776, in his *Observations upon the Air*, at a period when the analytical processes were infinitely less advanced and perfected than they are at present. Two ounces of hair afforded Citizen Berthollet one drachm and eighteen grains, or nearly a thirteenth of their weight of ammoniacal carbonate; two drachms and a half, or more than a sixth of their weight of water, having a very strong smell of burned hair, and ammoniacal from the commencement of the distillation; four drachms, or a fourth of their weight of an oil, very different from that which is obtained from the other animal substances: and lastly, there remained four drachms and a half, or more than a fourth of their weight, of a coal, the particles of which were very sensibly attracted by the magnet, and which he was not able to calcine. This chemist, is estimating at a drachm and a quarter the portion of water, of oil, and of ammoniacal carbonate lost, states at two drachms and eighteen grains the elastic fluids disengaged,

gaged, the nature of which he has not indicated, and which are manifeftly carbonated hidrogen gas, mixed with carbonic acid.

9. In the account of this analyfis, he infifts particularly upon the oil afforded by the hairs, on account of its large quantity, as well as of its very remarkable properties, and its difference from all the other oils obtained from different animal fubftances. This oil was yellow at firft, and became black only at the end of the diftillation. It did not alter the colour of the ammoniacal carbonate; it was very foluble in alcohol; it burned with the fcintillation and vivacity which every one remarks in the intire hairs when burning; it remained in a concrete form till the eighteenth degree of Reaumur's thermometer: its weight was not much different from that of the water charged with ammoniacal carbonate obtained in this analyfis; fo that when fluid it fwam at the top, and when concrete it funk to the bottom of this liquid. He concludes from thefe obfervations, that the hairs are principally compofed of oil; but this conclufion, which might be admitted ftill in 1776, but which can no longer be confidered as exact, muft now be confidered only as a fimple proof of the great difpofition which the hairs have to affume the oily character, as is proved in fact by their violent inflammation, their fufibility, their fatty nature, and the impracticability, not only of diffolving them in water, but even of wetting them. It

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is alſo to be obſerved that this opinion of the learned French Chemiſts accords with that of Haller, who, in his great phyſiological work, remarks a ſingular analogy between the hairs and the fat, the conſtant ſituation of the former in the latter, and the frequent circumſtances of morbid fatty concretions, or ſteatomes filled with hairs.

10. The quantity of carbonate of ammonia afforded by the hairs appeared ſo conſiderable to Haller, and ſtruck his attention ſo forcibly, that he was aſtoniſhed that J. Godard, who deſcribed the ſecret of the preparation of the Engliſh drops bought by Charles II. King of England, employed ſilk and not hair, which, he ſays, would have more eaſily afforded him an abundant quantity of this ſalt. This ſame abundance led Citizen Berthollet to doubt in 1760, whether the volatile alkali did not exiſt ready formed in the hairs; and it is certain that no animal ſubſtance affords it ſo abundantly or ſo quickly. It is likewiſe very remarkable that its coal is ſo difficult to be burned, and that it contains a very ſenſible quantity of iron attractable by the magnet. We ſhould be tempted to believe, according to this fact, that the hairs contain in their interior the colouring part of the blood, and that their coal, like that of this colouring part, contains phoſphate of iron. This coal is hard and brilliant, adheres ſtrongly to the glaſs, and reſembles carbonate of iron: there is reaſon to believe that this coal is

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alſo charged with phoſphate of lime; for Citizen Vauquelin and myſelf have found this ſalt in the hairs of the horſe and in the claws of ſeveral animals; and theſe parts have the moſt perfect analogy in their nature and compoſition with the human hairs. There is alſo a little carbonate of lime in the aſhes of hair; black hair even appears to afford more of it than fair.

11. The hairs are thoſe parts of the human body that endure the longeſt; they do not contain the ſame principle of decompoſition and of change of nature which exiſts in moſt of the other animal ſubſtances; they are more durable even than the bones; and in ancient ſepulchres in which the ſkeletons were reduced to powder, or intirely deſtroyed by the action of water and air, the hairs ſtill ſubſiſt, after having reſiſted the efforts of ages, and atteſt that human bodies had been depoſited in them. It is very eaſy to conceive that this preſervation depends intirely upon the corneous inſoluble nature of the hair, and that not being alterable either by air or water, which gradually melt and attenuate all the other animal ſubſtances, they retain their properties and their compoſition even in the midſt of the deſtruction which ſeizes upon all the organic parts. Garman in his Treatiſe *De miraculis mortuorum*, adduces a great number of facts and obſervations which prove this indeſtructibility and inalterability of the hairs.

12. Though ſo little alterable, the hairs are however not exempt from the impreſſion of ſeveral re-agents which more or leſs change their nature. Strong ebullition in water, frequently employed in the arts in which theſe bodies are worked, cauſes them to undergo a ſoftening and partial fuſion, the firſt ſigns of which are perceived in the hygrometrical action which cold water exerciſes upon them. Some perſons even pretend that when they are boiled for a very long time, they become intirely melted in the water and form a jelly; others aſſure us that it is only a portion of the covering of the hair, and not its proper interior ſubſtance, which diſſolves in the water, and affords the gelatin which is obtained from it. No chemiſt has hitherto examined this action with ſufficient attention. The decoction of hair is always coloured.

13. The acids alſo ſoften the hairs and diſcolours them: the muriatic acid whitens them at firſt, but they become yellow by drying; the nitric acid gives them a golden colour. The alkalis diſſolve them very well and reduce them to the ſtate of a kind of reddiſh liquid ſoap, diſengaging from them ammonia and approaching them to the oily ſtate. The metallic oxides in general burn, and conſequently blacken the hairs: they are frequently employed for colouring them upon the head. Thus when they are rubbed or impregnated with fat charged with red oxide of lead and lime, they become black

at the end of ſome days. There are alſo employed for this purpoſe acetite of lead, ſometimes even nitrate of lead, or the nitrates of mercury and of ſilver. After the uſe of theſe metallic ſolutions, the hairs are rubbed with oil, and become ſtill blacker by its contact. In all theſe phenomena hair greatly reſembles ſilk, more eſpecially the horns of the mammalia, the ſhell of the tortoiſe, &c. Thoſe properties which have been deſcribed relative to the epidermis alſo exhibit a great analogy with the texture of the hairs.

14. The nails, which anatomiſts juſtly conſider as a prolongation of the epidermis, and like this laſt, cover a mucoſo-nervous and papillary texture, grow, lengthen, and are renewed without limitation, as is exemplified upon the fingers of the Faquirs of Malabar. Duverny has compared them with horn, and Ludwig with hair, and in fact they are of a very ſimilar nature or compoſition. They ſoften by long maceration and decoction in water; this decoction is rendered but very little turbid by tannin,—ſtill leſs than that of the hair; they cannot be completely diſſolved. They diſſolve in the acids, are melted in the alkalies, are coloured and burned in the metallic ſolutions, and they adhere to colouring matters and are ſolidly dyed, as we may ſee by inſpecting the hands of dyers.

15. It may be concluded from all theſe facts, that the corneous animal texture and eſpecially the matter of the epidermis, of the

hairs

hairs and of the nails is an oxigenated gelatinous ſubſtance, little or not at all ſoluble, rendered ſolid, elaſtic, unalterable and very durable in its intimate nature, not only by its ſtate of oxigenation, but alſo by its union with a conſiderable quantity of phoſphate of lime, and even with a ſmall quantity of carbonate of lime; ſo that theſe concreſcible and little ſoluble ſalts, being depoſited with an oxigenated gelatinous matter exiſt as it were in the ſtate of a tanned ſubſtance. Every fact annonnces that theſe corneous textures, ſo abundant upon the ſurface of the body of man and of animals, are reſervoirs into which the exceſs of the nutritive matter and of phoſphate of lime is depoſited. The firſt is depoſited in them eſpecially at that period of their life when their growth has ceaſed; the ſecond is collected in them, eſpecially in thoſe animals from which the urine does not carry off this matter of the bones, as I ſhall ſhow in ſpeaking of the urinary liquids and of the oſſeous texture: accordingly, the mammalia of which I ſpeak, have their ſkin intirely covered with hair; whilſt man, whoſe ſkin is almoſt bare, evacuates by urine the exceſs or too great abundance of oſſeous matter.

ARTICLE

ARTICLE XI.

Of the Cartilaginous Texture.

1. THE cartilaginous texture has a confiftence and ftructure which fufficiently diftinguifh it from all others; it is an almoft folid body, white, of a milky tranfparence, confiderably refembling to the colour of the chalcedony or the opal, fufceptible of compreffion, highly elaftic, eafy to be cut, fmooth and polifhed in its fection, like a refinous matter, granulated or like fhagreen in its fracture. It has not the hardnefs of the corneous texture, but is intermediate between this fubftance and the ligament. The cartilages are moft frequently fituated at the articular extremities of the bones which they cover, and into the texture of which they enter, or between bones which they keep afunder and foften their friction, whether they be moveable or fixed. Sometimes they conftitute particular kinds of organs, as in the human larynx.

2. The ftructure of the cartilaginous texture is difficult to be determined and defcribed, and Haller acknowledged that it was much more obfcure than that of the bones. It is not diftinguifhed from the latter in the fœtus. Its difference from the offeous texture is very flight in

in thofe of the larynx and of the ribs; it is feldom or never converted into offeous texture in the two parts of the larynx and the ribs. In fome cartilages we fee, in the interior, a fort of core, or granulated texture, covered with a whiter and finer matter: it is very difficult to difcern laminæ or fibres in this part. The tendons that undergo a ftrong preffure, become converted into cartilages, like that of the peronæus longus in its paffage under the cubiform bone: the thyroid gland, the tunics of the large arteries, the fides of cyfts and of aneurifms frequently become cartilaginous. The firft rudiments of the bones in the human body are real cartilages; in the adult, and by the progrefs of offification, they have only a flight cartilaginous cruft at their extremity. The articular and inter-articular cartilages never become offified, on account of their continual humectation. The intervertebral cartilages formed into ligamentous rings at their extremity, and into a glutinous, thick, white humour, fimilar to a flakey ftarch, at their centre, become offified but very rarely.

3. Some familiar and domeftic facts are well adapted for affording a notion of the chemical nature of cartilage. It is known that this animal matter foftens in water; that, by its foftening, the laminæ, or the fibres which enter into its ftructure, become perceptible by fwelling, fplitting, detaching themfelves from the offeous furface in their divided part; that they affume

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the gelatinous nature by long ebullition, and the tranſparency which characterizes this ſubſtance. Theſe phenomena preſent themſelves at the extremities of the bones which accompany the meat which we boil, and many perſons prefer theſe cartilaginous parts when ſoftened and converted into jelly by boiling. Hunter, one of the anatomiſts who have occupied themſelves the moſt with the nature of cartilage compared with ſeveral other animal parts, has collected ſeveral experiments by which he has endeavoured to prove the difference of its texture from that of the bones. According to his experiments, the cartilages are not ſoftened in the acids; they diſſolve completely in hot water. They are not coloured like the bones, or along with them by madder mixed with the food of animals.

4. To theſe characteriſtic properties it is added, that the cartilages do not exfoliate in diſeaſes; that they do not ſoften like the bones; that they are not re-produced after having been deſtroyed. Theſe comparative obſervations we owe to Hunter. Haller concludes, from a compariſon of theſe facts, that cartilage is formed of thickened gluten, into which it may be converted by art; that this gluten receives, as it becomes concrete, a ſlight portion of calcareous matter, or of phoſphate of lime, which renders it ſolid; that it is on this account that cartilaginous texture is formed in the ſides of the arteries, in the membranes of the ſpleen, in the

the thick part of the pleura, of the pericardium into which a glutinous humour is poured; that their offification, which takes place in fome cafes, or with very old fubjects, depends upon a too great quantity of calcareous matter, which is precipitated and collected in their afcular texture, as well on account of its known fuperabundance in old perfons, as by the dilatation of the veffels which convey the nutritive juice. This great anatomift concludes from the analogy of the cartilage with the bones, that there muft exift in the one as well as in the other, fibres and laminæ, but that they are concealed by the opaque and homogeneous gluten, which covers them on all fides.

5. While borrowing thefe general confiderations from the immortal work of the Helvetian phyfiologift, I have endeavoured to fupply the filence of the chemifts refpecting the nature of the cartilages: I do not know of any particular analyfis having been made of them. If what Haller advances were perfectly exact, it would follow that the cartilages are of a compofition fimilar to that of the corneous texture; but this analogy, at leaft if taken in all the latitude in which it is here prefented, is not probable, becaufe the mere afpect of the cartilaginous texture, its living properties, and its morbid alterations, prove that there exifts a very remarkable difference between the two textures. We muft indeed admit the prefence of the phofphate of

lime

lime in cartilage, as well as in the corneous texture; but it appears, that befides a remarkable difference in the proportion, the gelatinous matter of the firft differs from that of the fecond by a modification, which chemiftry is alone able to determine, and may throw much light upon the very imperfect knowledge we yet poffefs of the intimate nature of cartilage.

Article XII.

Of the Offeous Texture.

1. THE fyftem, or the totality of the bones, which fupport the whole animal machine, and give its general figure, its fize and its firmnefs, forms the laft folid texture which remains to be examined; for the bones are the laft parts which we find in the order of diffection; thofe which conftitute the laft term of nutrition, and into the nature of which feveral of the preceding textures pafs. There exifts in the animal economy a power which tends to produce the offeous matter, and to depofit it in moft of the other organs. Accordingly, the natural termination of life in animals feems to depend upon this offification which predominates over the other functions, and oppofes their exercife. The bones conftitute one of the parts

the moſt generally diffuſed throughout the whole continuity of the animal body, for here is no region of which the baſe is not a ſolid or oſſeous organ. They muſt, therefore, be reckoned amongſt textures belonging to the whole animal economy, and performing one of the principal functions of life which ſupport its exiſtence.

2. All the bones being connected together by ligamentous fibres, united and articulated, form a ſyſtem ſubdivided and moveable in a great number of points; without being removed or ſeparated in the healthy ſtate; they conſtitute all together what is called the ſkeleton. Their ſolidity, their white colour, their elaſticity, and their denſity, diſtinguiſh them ſufficiently from all the other organs. In order to characterize them, they are diſtinguiſhed, amongſt the numerous bones which form the ſkeleton, into the flat, the long, the cylindrical, the cubical, &c. We obſerve in them poliſhed ſurfaces, cavities, eminences, or apophyſes, depreſſions, impreſſions, aſperities, grooves, ſinuoſities, canals, which, whilſt they characterize each in particular, remind us, by their mere aſpect, of their relations, and contiguities with many other parts, with the uſes for which they are deſtined. Their extremities generally preſent projecting or excavated ſurfaces, fittings, heads, cavities, condyles, pullies, either naked or more frequently covered with cartilages deſtined for uniting them cloſely with the contiguous

tiguous bones, or permitting them to move, to ſlide upon each other, and to change their reſpective ſituation more or leſs conſiderably. In young animals, the bones are more numerous, many of them being ſeparated into ſeveral others, and preſent detached or diſtinct parts, which are called *epiphyſes*. Theſe ſeparated parts diſappear with advancing age, and the bones even adhere at ſeveral points to one another, ſo that in old age the ſkeleton tends to form only a ſingle piece. All the bones are covered with a membrane which adheres very ſtrongly to them, in ſeveral very diſtinct laminæ, and is called the perioſteum. Anatomy occupies itſelf with this external ſtructure, with the deſcription of the bones one after the other, in ſo accurate and detailed a manner, that great part of the works upon this ſcience is conſecrated to it, beauſe it is conſidered as the baſe of all the other parts of anatomical knowledge. The inſtructed eye, on ſurveying the ſkeleton, ſoon applies to it all the other parts, ſo that it becomes the type upon which memory raiſes, as nature herſelf ſeems to have done, the whole edifice of the animal body.

3. The internal ſtructure of the bones is no leſs important to be known than their ſurface and their figure, eſpecially in order to arrive at the determination of their intimate nature or compoſition. Theſe ſolid organs appear, when broken, to be formed of laminæ applied

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to each other, fometimes very clofe and compact, as in the centre of the long bones, fometimes feparate, and leaving between them porous cavities, prefenting fmall veficles, like thofe of a fponge: accordingly, this latter texture is called fpongy or cellular. The flat bones are, in general, formed of two tables, having a fpace between them, and fupported by fome folid fibres paffing out of one table into the other; the intervening fpace is filled with a reddifh foft texture, which is called *diploe.* In the long bones, there is a medullary cavity or canal, full of a kind of fat called *marrow*, which is depofited in a cellular membrane detached from the interior periofteum, and itfelf fupported upon fome offeous laminæ, or fome filaments detached from the internal furface of thefe bones; blood-veffels which perforate the body of the bone obliquely arrive at this internal periofteum, and pour into it the liquid which nourifhes them. The middle part of the long bones is compofed of very clofe laminæ, forming a confiderable thicknefs: towards the extremities thefe laminæ diverge from one another, feparate, and form by their feparation offeous cells, which conftitute the whole thicknefs and the whole ftrength of the heads of the bones; fo that thefe dilated extreme parts, which are very thin in their external offeous layer, neverthelefs refift a great degree of preffure by the confiderable number of plates and of folid columns which bear upon the

the internal furface of the layer. The cellular texture of thefe dilated extreme parts, or of thefe heads, of thefe condyles of the long bones, is filled with a juice analogous to the diploe which is found between the tables of the flat bones. However clofe the laminæ of the bones may be in their folid part, they neverthelefs eafily fuffer a part of the medullary oil placed in their interior cavities to infinuate itfelf between them. The bones have an elaftic texture fufceptible of a certain degree of extenfion, of a certain elongation before it breaks.

4. The external and internal ftructure of the bones has been known much earlier than their intimate nature or compofition. Exact and even minute defcriptions of their furfaces, their flighteft inequalities, of all their parts, were already completed; the great works of Vefalius, of Columbus, of Riolanus, of Clopthon-Havers, of Albinus, of Monro, of Bertin, and of many other celebrated anatomifts, had brought this defcriptive part to its perfection; many curious refearches had even been made upon ofteogeny or the formation of the bones; and the valuable difcoveries of Kerkringius, of Duhamel, of Fougeroux, of Haller, of Troja, &c. had already thrown fome light upon this beautiful part of phyfiology, before chemifts had difcovered the real nature of thefe organs. Till 1774, we contented ourfelves with diftilling the bones, determining their products in an

inaccurate

inaccurate manner, loofely ranking their bafe amongft the earths, though it had been fufpected that it had conftituted a particular earth. Papin, Heriffant, Laffone, Haller, had carefully diftinguifhed and proved by experiments that the bones were formed of two different fubftances; the one glutinous, fufceptible of diffolving in boiling water, and forming a jelly which was prepared for the ufes of feveral of the arts; and another fubftance which had been confidered as calcareous or abforbent; when one of thofe capital difcoveries, which tend to change the afpect of the fcience, was made by two Swedifh chemifts. Gahn and Scheele proved, by exact experiments, that the pretended offeous earth was an earthy falt compofed of phofphoric acid and lime, which could not confequently be converted into lime by the action of fire, nor faturate the acids after the manner of an ordinary abforbent earth. This difcovery was foon confirmed by a great number of chemifts, efpecially in France, where the procefs of the decompofition of the bones, as well as the art of extracting the phofphorus, was fimplified by Rouelle the younger, Macquer, Poulletier de la Salle, Nicolas de Nancy, and Berniard. It will foon be feen that by a late courfe of inquiries made by Citizen Vauquelin and myfelf in conjunction, we have added a new degree of precifion to the analyfis of the calcareous phofphate of the bones.

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5. The bones expofed to fire in contact with the air, if we begin by a mild temperature, firft dry and become brittle; then a fatty oil efcapes from their interior and turns their external layers yellow. To the aqueous vapour which is firft exhaled, fucceeds, when the action of the fire is augmented, a fetid and greafy fmell; the furface of the bone becomes brown, a thick white vapour is difengaged from it; it then takes fire, and continues to burn till the whole of its oil is diffipated. The bones are then black and in the ftate of coal when they are fuffered to cool; but when they are heated to rednefs, their coally matter burns from the furface to their internal part, and they are at laft changed into a white friable fubftance, infoluble in water: fuch are the calcined bones which are ufed in the arts for rubbing and polifhing diamonds, and forming cupels. Thefe calcined bones, lixiviated in water and by the acids, afford a little carbonate of foda, carbonate of lime, and a large quantity of calcareous phofphate. The proportion of this faline earthy fubftance, with refpect to the whole bone, is 0,65 as the average term of many varieties with refpect to the age, the ftate of this organ, its folidity, &c. If we heat the calcined bones to an intenfe rednefs, they experience, at the fame time emitting a yellowifh phofphoric light with which they feem to be penetrated, a femi-fufion which affimilates them to the ftate of porcelain. They have a fine

close semi-vitreous grain, a great degree of density, a semi-transparency, and that soft aspect which belongs to all the vitrified earths.

6. When we treat the bones in close apparatuses, distil them in a retort, from the mildest temperature which is usually employed in these operations to the most intense heat which these vessels can support, we obtain water which gradually assumes the oily ammoniacal colour and smell, oil partly liquid and light, partly heavy and concrete, of a brown-red colour, very fetid; carbonate of ammonia dissolved in water and in a concrete form, soiled by a portion of oil, a carbonated and sulphurated hidrogen gas, and carbonic acidg as. There remains in the retort a coal which retains the form of the bone that has been put into the vessel. When we carefully examine the water which is obtained in considerable abundance in this distillation, we find in it, besides the ammoniacal carbonate, a small quantity of sebacic and of Prussic acid combined with ammonia: the thick oil, separated from the other products and subjected to rectification, becomes in part liquid, volatile, of an almost aromatic smell, and in every respect similar to what is called *Dippel's animal oil;* it is always a little ammoniacal, and turns the syrup of violets green. The coal calcined in open vessels heated to whiteness, affords the same results as those which have been enunciated in Article 5. Formerly the products of the distillation of the bones were

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employed in medicine, and thofe obtained from the human cranium, or from the horns of deer, were preferred. It is very evident that thefe products of the combuftion and of the diftillation of the waters, with the vapours, the inflammation, and the liquid and gafeous products, are owing to the gelatinous or truly animal portion of thefe parts; for the earthy falts can neither be their caufe or their fource.

7. Bones expofed to the air gradually become dry, brittle and arid; they become white when they are long expofed to the dew; and afterwards turn yellow, efpecially by age and during hot feafons; whilft they thus acquire colour, they become greafy and oily at their furface. After a great length of time having been turned brown by a kind of flow combuftion, they decay, feparate into fmall fcales, and fall into powder. It is in this manner that they are gradually deftroyed in the fields and in burying places; but ages are fcarcely fufficient to effect this deftruction. I have examined fome that had remained nearly three hundred years in a charnel-houfe, defended indeed againft the rain, which were ftill very hard and elaftic, and contained their gelatinous part almoft entire. Van Swieten mentions a fkeleton kept in his mufeum, the bones of which were fpontaneoufly deftroyed, and fell into powder by the effect of a virus which, according to him, ftill exifted in this fubject, and re-acted upon the texture and the compofition of its

 bones.

bones. It is known that theſe organs receive, and eaſily promote the germination of ſmall ſeeds of vegetables which cover their ſurface with a greeniſh moſs; that when buried in the ground, they admit carbonate of lime into their pores, which the water depoſits between their layers, at the ſame time depriving them of a part of their gelatin; that they are ſometimes incruſted with it, and improperly take the name of *petrified bones*; and laſtly, that when penetrated by a ſolution of oxide of copper, they acquire a green colour, and are called *turquoiſes*.

8. The action of water upon bones is one of the phenomena which has been the longeſt known, and which has been employed with the greateſt ſucceſs for determining their nature. Cold water acts but very ſlowly upon theſe organs; when they remain in it for ſome days, it gradually penetrates their pores, divides and ſeparates their laminæ, and ſoftens their gelatinous parenchyma: their medullary juice is eaſily converted into adipocirous matter. Boiling water attacks their texture, when they have previouſly been reduced into ſmall fragments, into chips, into powder, or into thin laminæ; it diſſolves their white cartilaginous matter, and quickly changes it into very pure gelatin: theſe bodies are in preference uſed for preparing the whiteſt, the moſt tranſparent, and the mildeſt jelly, which is the moſt ſuſceptible of receiving all the moſt varied taſtes, perfumes, or ſeaſonings. Thus a light and agreeable

agreeable aliment is extracted from hartſhorn. Thus ivory and bones afford a nutriment uſeful in certain circumſtances. The gelatinous ſubſtance of the bones is ſoftened in theſe organs in their entire ſtate, when they are ſubjected to water raiſed to a temperature much ſuperior to that of its ordinary ebullition, as takes place by the ſtrong compreſſion in Papin's machine or digeſter, in which the moſt ſolid bones are ſoftened in a few minutes. Theſe bodies, thus deprived by the water of their gelatinous ſubſtance, become afterwards, when ſlowly heated, dry, brittle, and friable; and their laminæ ſeparate eaſily from one another. I ſpeak here only of the action of water upon the oſſeous laminæ when pure and ſeparated from all that does not belong to them. The proportion of this gelatin, *extracted* from bones by means of water, appears to be from 0,25 to 0,35. If we heat entire and freſh bones in this liquid, their perioſteum, as well as the tendons and ligaments which remain attached to it, are diſſolved and increaſe the proportion of gelatin; their marrow melts and collects at the ſurface in the form of oil. This is the reaſon why they contribute to the mild and unctuous alimentary quality of broth. The ſtomach and the digeſtive power effect the decompoſition of bones ſtill better than hot water, and thoſe animals which take them as food, diſcharge them in a great meaſure deprived of their gelatinous matter, as is proved by the

 chemical

chemical analyfis of the excrements of dogs that eat bones, excrements formerly called in the materia medica by the ridiculous name of *album græcum.*

9. It has long been known that the weakeft acids have the power of foftening bones, and of diffolving that part of them which was called *earthy*. Heriffant, in examining this phenomenon with fome attention in a Memoir inferted amongft thofe of the Academy of Sciences of Paris, for 1758, thought he had found in the nitric acid (with which he foftened the bones which he foaked in it, by diffolving their earth, which he believed to be cretaceous, without affecting their membraneous cellular part) a means of infulating the two conftituent matters of thefe organs. Haller has verified this foftening of the bones even by the acetous acid and lemon juice: he fufpected that in the foftening of the bones by the effect of difeafes, there exifted an acid which thus corroded them. All the chemifts have afterwards obferved that a folution of bones in an acid precipitated by alkali affords a feemingly earthy matter, which does not poffefs the property of becoming quick-lime by calcination. It is to Scheele that we are indebted for the true knowledge of this phenomenon. After having, like Heriffant, diffolved bones in the nitric acid, he filtrated the liquor, and afcertained that, though always acid, even when faturated with all that it could diffolve of bone, it precipitated

fulphate

ſulphate of lime by the addition of concentrated ſulphuric acid; and that after this precipitation, the ſolution drawn off clear, and evaporated in a retort, afforded volatilized nitric acid, and left phoſphoric acid, which was fuſed into glaſs by the action of a ſufficient heat. He concluded from this experiment that the nitric acid diſſolved the phoſphate of lime, the baſe of the bones; that the ſolution in this acid was a mixture of calcareous nitrate and of phoſphoric acid; that when the firſt was decompoſed by the ſulphuric acid, and the precipitated ſulphate of lime ſeparated from it, there remained only a mixture of the two acids, the phoſphoric and the nitric, and that this latter mixture, when heated, diſengaged volatile nitric acid, whilſt the fixed phoſphoric acid remained at the bottom of the retort. We ſhall ſoon ſee that things do not happen exactly in this manner: but before we prove this, it is neceſſary that we ſhould give an account of what chemiſts have done reſpecting this action of the acids, between the epocha of the diſcovery of Scheele, and that of our own inquiry, the laſt that has been made to my knowledge upon this kind of analyſis.

10. Poulletier de la Salle and Macquer firſt repeated, at Paris, Scheele's analyſis of the calcined bones, and found it accurate with reſpect to the preſence of the phoſphoric acid in the bones, and the art of extracting phoſphorus from them. Rouelle the younger, when he

alſo occupied himſelf with this ſubject, obſerved ſeveral important facts, and deſcribed them with much accuracy in the Journal de Medicine of the month of October, 1777. Such are, amongſt others, 1. the means of ſeparating carefully, by repeated decantations and filtrations, the ſulphate of lime formed in the proceſs of Scheele; 2. the examination of the liquor after evaporation, by oſſeous or calcareous nitrate, in order to aſcertain the preſence of the ſulphuric acid in it by the precipitation; 3. the portion of ſalt thrown up and not volatilized in the diſtillation of this nitric and phoſphoric liquor, by the jets formed in the thick liquid; 4. the decompoſition of the ſulphate of lime by the concentrated phoſphoric acid; 5. the ſtate of the opaque vitreous phoſphoric maſs remaining in the retort, and preſenting a mixture of this acid, of the ſulphuric, of baſe of bones or phoſphate of lime, and of ſulphate of lime; 6. the difficulty of ſeparating the pure phoſphoric acid from this maſs; the means of effecting this ſeparation by lixiviating, concentrating the lixivium by fire, and adding alcohol which precipitates the phoſphoric acid in white flakes; 7. laſtly, the fuſion of this acid, thus prepared and purified into a very white and very tranſparent glaſs, and the poſitive proof that the earth diſſolved by the nitric acid, and afterwards carried off by the ſulphuric, is really calcareous: a proof which conſiſts in precipitating it from the ſulphate depoſited

depofited by the carbonate of pot-afh, and calcining the precipitate in order to reduce it to the ftate of lime.

11. Citizen Nicolas, a chemift of Nancy, a fhort time after the inquiry of Rouelle, gave a new and much more fimple procefs for extracting the phofphoric acid from bones; a procefs which contributed to elucidate their nature. Upon bones calcined to whitenefs, pulverized, paffed through the fieve, and placed in a veffel of ftone-ware, an equal part of concentrated fulphuric acid is poured; the mixture is ftirred with a fpatula of glafs; and a fufficient quantity of water is added to bring it to the confiftence of thin foup. After fome hours contact and repofe, during which it thickens, the mixture is placed upon a double linen cloth fufpended upon a fquare frame; it is wafhed with water till it ceafes to be acid, and to precipitate lime-water, or till the water has diffolved all the phofphoric acid: the mixed water are evaporated, and by means of the filtre, the fulphate of lime is feparated in filky ftraws or filaments, which are depofited during the evaporation, and muft be well wafhed with a little water. This feparation is continued till the liquor no longer depofits any thing; the concentration is then continued fo far as to give the liquor the confiftence of a foft extract: it is heated pretty ftrongly in a large crucible, in which it fwells and exhales a fulphureous and aromatic fmoke, in order either

to

to give it a ſemi-vitreous form, or even to vitrify it completely into a tranſparent glaſs without bubbles, which cannot be obtained except by keeping it fuſed for a ſufficient time. If it be propoſed to extract the phoſphorus from it, the operation is continued only till it has the conſiſtence of honey; for the phoſphoric glaſs does not afford this combuſtible body without great difficulty.

12. Since the publication of the proceſs of Citizen Nicolas, chemiſts have all contented themſelves with repeating it upon different kinds of bones, in order to compare them with one another, and to determine the quantity of phoſphoric acid which each of them is able to yield. Berniard has thus compared foſſil bones, thoſe of the whale, of the elephant, the porpoiſe, of the bullock, of man, the horns of the elk, the teeth of the ſeal, ivory. Bullion has extracted it from the bones of fiſh and from ivory, from which Rouelle had ſaid he was not able to obtain it. Citizen Vauquelin and myſelf, in our reſearches upon the animal matters, had occaſion to examine with much attention the phoſphoric acid extracted from bones, and to compare it with that produced by the deflagration of phoſphorus; from which it differs in ſome properties. We remarked that that of bones aſſumed by evaporation to a ſolid conſiſtence, the form of pearly ſtraws; that when thus dried, it attracted the humidity of the atmoſphere but very feebly; that

that when fufed into glafs it was no longer acid, nor hardly foluble; we alfo found that the calcined bones, diffolved in the muriatic acid, afforded likewife, by fpontaneous evaporation, 0,33 of fcaly cryftals, brilliant, acidulous, fufible into an infoluble glafs, becoming very foluble by any acid, and efpecially by an excefs of phofphoric acid; that is, in every refpect fimilar to what is obtained from bones by the fulphuric acid. The nitric, the acetous and the acetic acids, &c. gave us a fimilar fubftance with the calcined bones. This matter, which reddens the blue colours, and is precipitable from its folution by ammonia, the cauftic alkalis and lime water, into infipid and infoluble calcareous phofphate, prefented us with all the properties of an acidulous phofphate of lime.

13. We found by thefe firft experiments that the bones were not completely decompofed by the acids, though they all alike poffefs the property of foftening them and diffolving their folid part; that their phofphate of lime was only in part decompofed; that the acids took from it only a portion of its bafe, and reduced it to the ftate of acidulous calcareous phofphate; and that there their action ceafed. We afterwards found, by other experiments, that the acidulous phofphate of lime might alfo be prepared with the bafe of bones and the phofphoric acid; that this acid, when pure, decompofed the muriate, the nitrate and even the

the fulphate of lime, lefs indeed than the two firft, and thus formed acidulous calcareous phofphate, always cryftallizable into fmall brilliant and micaceous ftraws; that this acidulous phofphate contained 0,54 of phofphoric acid, and 0,46 of lime; whilft the phofphate of lime, of bones, or the well faturated phofphate, contained 0,41 of phofphoric acid, and 0,59 of lime; that in treating the latter by the acids, only 0,24 of lime was taken from it; that 100 parts of calcined bones, treated by the fulphuric acid were charged into 76 parts of acidulous phofphate, formed of phofphate of lime 59, and of phofphoric acid 17 parts; that there were only thefe 17 parts of free acid which afforded phofphorus in the diftillation with charcoal; that the portion of neutral phofphate of lime remained in the refiduum of this operation, and that it was on this account that from 100 parts of bones, according to the moft exact calculations of Pelletier, who has given excellent details upon this preparation, only 0,05 of phofphorus, at moft, were obtained; whereas the 100 parts of bone really contain 0,16 to the 0,41 of phofphoric acid which they contain.

14. This knowledge which we acquired concerning the femi-decompofition only of the offeous calcareous phofphate, by the acids, and the formation of an acidulous phofphate, afforded ufeful refults for the extraction of the phof-

phofphoric acid of bones, their analyfis, the preparation of phofphorus, and even for ofteogeny.

Calculation and experiment have taught us that only $\frac{2}{5}$ of their weight of concentrated fulphuric acid muft be employed for decompofing the calcined bones, inftead of $\frac{2}{3}$ which chemifts had directed.

In order completely to analyfe the bones, and to afcertain the proportion of phofphoric acid and lime which they contain, after having diffolved their earthy bafe by any acid, as the nitric or the muriatic, this folution muft be precipitated by the oxalic acid, which decompofes the acidulous phofphate of lime, like all the other calcareous falts, and confequently leaves the phofphoric acid nearly free in the liquor, fwimming above the precipitate which it forms, which containing in 100 parts 0,48 of lime, thus indicates the quantity of this earth. No alkaline carbonate decompofes the acid phofphate of lime, nor confequently can they ferve for this complete analyfis.

As that which is obtained from bones treated with the fulphuric acid, yields phofphorus only in proportion to the excefs of phofphoric acid in the acid phofphate of lime, if we treat the lixivium with nitrate or acetite of lead, we decompofe completely, and by neceffary double elective attraction, the acid phofphate of lime; all its phofphoric acid is depofited in union with the lead; all its lime

lime remains in folution, combined with the nitric or acetous acid. The precipitate well wafhed, and diftilled with charcoal, affords a quantity of phofphorus, more than twice as large as the fimple product of the evaporation of what was called *phofphoric acid of bones;* we thus obtain from 0,08 to 0,12, inftead of 0,05, which had hitherto been extracted.

The very eafy and abundant folubility of the offeous phofphate of lime in the phofphoric acid, and the fpeedy formation of acid calcareous phofphate, explain a feries of important phenomena relative to ofteogeny and the difeafes of the bones, which are not to be detailed here, but which will be found elfewhere.

15. The cauftic alkalies, and the alkaline carbonates have no action upon the offeous phofphate of lime, and do not effect any decompofition of it, though chemifts have thought fo, and have even propofed to fufe calcined bones with the carbonate of pot-afh, or of foda. It is a fact, of which Citizen Vauquelin and myfelf have well convinced ourfelves, and which we have confirmed by very exact experiments. It will be feen hereafter that this impoffibility of decompofing the phofphate of lime by the carbonate of pot-afh, either in the dry or in the humid way, oppofed to the facility with which the oxalate of lime is decompofed by the fame falt, has afforded much light refpecting the analyfis of feveral

kinds

kinds of urinary concretions. The alkalies and their carbonates, in ſolution, act upon the gelatinous matter of the bones, which they thus ſoften, and the extraction of which they favour. No ſalt has any real action upon the oſſeous texture.

The metallic oxides, and their ſolutions in the acids, burn its membranous part more or leſs powerfully, or colour it, at the ſame time penetrating it, when they are diluted with water; in this manner it is that the ſolutions of copper turn the bones that are expoſed to their contact green, and artificial turquoiſes are formed in pieces of bones, ſuſpended in very weak nitrid acid, or even in other liquids, when only a mere pin of copper is at the ſame time immerſed along with them.

16. Amongſt the vegetable matters, if we except the acids already indicated, we know only the oils and ſome colouring matters that are capable of penetrating the oſſeous texture, undoubtedly in its gelatinous ſubſtance, and giving it either an unctuous flexibility, or a ſoft poliſh, or a more or leſs intenſe colour. It is known, relatively to this laſt mentioned fact, how eaſy it is to dye the oſſeous ſurface, and even to cauſe the colour to penetrate conſiderably between their deep-ſeated layers; and alſo how ſtrongly the colouring matter adheres, and what livelineſs it aſſumes in them, as is exemplified in the various toys of ſtained bones which are daily manufactured. We alſo ſee a ſtriking proof

proof of this adhesion of the colouring matters with the bones in the brilliant rose-colour, which the bones of living animals contract from madder, mixed with their aliments. The fine tinge which this vegetable gives them seems to announce that its colour is brightened by an acid before it is deposited amongst the osseous laminæ.

Amongst animal matters, the fats and the coloured substances act like the preceding bodies upon the bones; the acids which are produced by the spontaneous alterations of these living matters, dissolve the phosphate of lime, and soften the osseous texture as easily as those which belong to the fossils or to the vegetable compounds.

17. The whole of the facts relative to the osseous texture prove that it is a compound of two principal substances, a gelatinous or glutinous base, and an insoluble salt. The first constitutes its true organic type; it is this which exists at first as membrane, as cartilage, and which gradually becomes filled by the progress of ossification in young animals, with small crystals of phosphate of lime which furnish its areolæ, and there assume the granulated, lamellated, cellular form, which is determined by that of these primitive areolæ, after the manner of a kind of mould. The first dissolves in water, is gradually decomposed, and leaves the bones brittle in proportion as its quantity diminishes. The other being soluble in all the acids which carry it off, reduces the bone in proportion as it is

is diſſolved to its primitive cartilaginous or gelatinous nature. The one gives the primitive form, the pliability, the ſoft and poliſhed texture. The other produces the ſolidity, the hardneſs, the reſiſtance, and the permanent form. The firſt if it predominates, permits the bones to extend themſelves, to form apophyſes, ſinuoſities, and depreſſions, by the attracting action of the muſcles and the compreſſing action of the arteries &c. The ſecond, when it comes to be predominant, oppoſes the change of form, renders the bones dry and brittle, frequently adds to their thickneſs, renders them deformed, enlarges them irregularly, and fills their cavities.

18. But though the general and in ſome ſort common or average nature of the bones is at the preſent day well known; though their analyſis throws ſome light upon their formation and the alterations of which they are ſuſceptible; yet much ſtill remains to be done, and what lights may we not expect from future labours and reſearches upon the bones of the fœtus compared with thoſe of the adult and of old men; upon thoſe of the different animals compared with the human bones, eſpecially in the inferior orders of the amphibia and of the fiſhes, whoſe organs and functions, ſo different from thoſe of man muſt produce ſuch remarkable differences in the nature and compoſition of their parts. How many intereſting facts will be preſented to phyſiologiſts by a well conducted examination of bones that have

been

been buried for a longer or ſhorter time in the earth, expoſed to the air or immerſed in the water, and changed more or leſs conſiderably in their intimate nature, either by the ſubſtraction of ſome of their conſtituent materials, or by the addition of ſome foreign matters.

19. A vaſt career is ſtill open to chemiſts, if they chooſe to apply the means which they already poſſeſs to the highly intereſting experiments upon oſſification, and the regeneration of the bones, commenced under other relations by Duhamel, Fougeroux, Haller and Troja; if they compare the progreſs of the formation and the ſolidification of theſe organs in the fœtus and in the young animal, at different periods, with the quantity and the nature of its aliments; if by varying theſe, and adding to them ſubſtances which are known to influence the colour and the conſiſtence of the bones, they follow with all the requiſite attention the relations of both; if they multiply theſe uſeful experiments in animals of different orders, in the frugivorous and carnivorous mammalia, in the aquatic fowls and the birds of the foreſt, in the amphibia, and even in the fiſhes; if by laying bare the bones in ſome points in theſe living animals and inveloping the oſſeous parts with different ſubſtances, or with different elaſtic fluids, they thereby appreciate the influence of theſe contracts and the kind of alteration to which they give riſe; if the external irritation and the deſtruction of the external perioſteum, with the internal

ternal irritation and the diſorganization of the marrow, be obſerved with care, and combined with the other modes of experimenting adopted by Duhamel and Fougeroux.

20. The proſpect enlarges and affords hopes of ſucceſs ſtill much more important than the preceding, when theſe exact analyſes, theſe valuable reſearches ſhall have been extended to diſeaſed bones, ſoftened as it were, fuſed in the Rachitis, the lacteal affections, hardened and ſwelled in exoſtoſes of different kinds, corroded and deſtroyed in different kinds of caries, dry or humid, ſlow or rapid; ſplit, diſtended, inflated in the *ſpina ventoſa*, the necroſis; re-formed, regenerated, doubled in the ſequeſtra, fractures, callus. All theſe alterations ſo well deſcribed and known by the moderns, in which they have found ſubjects of obſervation which had eſcaped the ancient phyſicians, and views of treatment, with motives for prognoſticating the cure which had been intirely neglected before; theſe cannot be really underſtood, nor their cauſes appreciated, their curative treatment reſcued from the mere empiriciſm that has hitherto directed it, unleſs by poſitive experiments, well inſtituted analyſes, for which the preſent ſtate of chemiſtry preſents means ſo new and ſo ſuperior to thoſe which the ſcience formerly poſſeſſed.

Article XIII.

Of the Animal Matters contained in the Osseous Cavity of the Cranium, or proceeding from it.

1. IN the twelve preceding articles, we have ſpoken of the different liquid and ſolid matters which are generally diffuſed throughout the whole body, and which conſtitute, as it were, its ſolid elements. In the preſent article we ſhall treat of the matters which are found in the cavity of the cranium. We ſhall not, however, ſpeak of the membranes, the dura mater, the pia mater, and the arachnoid; nor of the ſanguineous veſſels, as theſe bodies preſent nothing different from what has been ſet forth in general concerning the membranous and vaſcular texture, in one of the preceding articles. We ſhall treat of the cerebral matter, of the nervous fluid, of the liquor of the ventricles, and of the pineal concretions: theſe are in fact the four ſubſtances particularly contained in the cranium, and which, preſenting an aſpect, a ſtructure, or phyſical properties different from theſe which occupy other cavities of the body, conſequently deſerve a particular examination. Two of theſe matters belong to the animal liquids, another to the ſoft part, and the laſt to the ſolids.

SECTION.

SECTION I.

Of the Cerebral and Nervous Pulp.

2. THE brain, this vifcus fo regularly organized, and fo voluminous in man, in whom it exceeds in weight the relative quantity contained in the cranium of any other animal, is furrowed at its furface into a multitude of grooves, elevated into protuberances at a number of points, prefenting tortuous inequalities which have been compared to the inteftinal circumvolutions, forming, at a fmall depth beneath this unequal and, as it were, carved furface, a homogeneous mafs, of a grey colour externally, in its cortical layer, or cineritious fubftance, it is of a milk or ivory-white colour in its interior, prefenting in its continuity an admirable feries of forms, of colours, of protuberant, rounded, elongated parts, of cords, cavities, and tubercles, conftant and regular in all individuals. This organ, which the anatomifts, and efpecially Soemmering and Vicq-d'-Azyr, have fo well defcribed, without however having been able to fay any thing concerning the ufes of all its very diverfified parts; this anatomical and phyfiological enigma, which no naturalifts has yet been able to unravel, reprefents a kind of thick pafte, of a more or lefs

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ſolid pulp, divided into the cerebrum properly ſo called, the cerebellum,, and medullary prolongations, which proceeding from theſe two centres, give riſe to the medulla oblongata, to the pairs of nerves, and to the ſpinal marrow. The nerves which proceed from the baſe of this viſcus, and thoſe which paſs from the ſpinal marrow to diffuſe themſelves throughout the whole body, and give it the cauſe of motion and ſenſation, are themſelves real cerebral emanations, covered with membranes borrowed from the membranes of the medulla itſelf, from which they detach themſelves, and relinquiſh them where they enter the parts to which they communicate the powers of motion and ſenſation.

3. The curious form and ſtructure which this viſcus exhibits, its ſize and quantity correſponding with the intellectual faculties of the animal, the ſenſes which are contiguous to it, and, as it were, its neareſt appendages, the internal ſenſation which appriſes every one that the conſciouſneſs of his actions, his deſires, his will, the exerciſe of all the faculties of his mind refer themſelves to the interior of his head; the leſion of the function of the nerves, of motion, of ſenſation, even of thought, the madneſs, the fatuity which conſtantly accompany morbid changes produced around or in the interior of the cerebral texture, of whatever nature they may be; the lethargy, the imbecility, the fatuity, the idiotiſm, which are the conſequences

consequences of pressure applied to these organs—all announce that the brain is the seat of the sensations, the sensorium commune, the grand focus of life, and the general source of the functions, which are called *animal* or *intellectual*. The anatomy of animals, pursued in all the orders of these organized beings, from man down to the testacea and worms, confirms this general notion, by showing the progressive degradation of the organization, of the mass, and of the different portions of this viscus, corresponding with a kind of striking precision with the diminution of sensibility, of intelligence, of instinct, and of sensitive organs in these beings.

4. Incomprehensible to the most able anatomists, who have best understood and demonstrated its numerous circumvolutions, its most hidden structure, its most delicate parts, this viscus presents no more hold, or rather it affords no more satisfactory results to the chemist than to the physiologist, who has examined only its structure. The one, after the most persevering labours, is no less astonished than the other, at the small degree of relation which he finds between his result and the properties of this living organ. Few learned men have yet occupied themselves with the analysis of the cerebral pulp, or medulla; and, before the most modern times, they had not even the curiosity to attempt to investigate its nature and composition; there were scarcely more than a few facts, borrowed

borrowed from the art of cookery, or obferved in the proceffes employed by anatomifts for demonftrating the different parts of the brain, that had afforded a fuperficial notion of its chemical properties. Garman had announced its fingular prefervation in the offeous cranium of buried bodies. Burrhus had compared its texture with an oil, and had even confidered it as approaching to the nature of fpermaceti. Citizen Thouret firft defcribed a feries of experiments upon the nature of the medulla of the brain, in a Memoir publifhed amongft thofe of the Society of Medicine, and reprefented it as a kind of faponaceous fubftance, compofed of an oil and fixed alkali. I publifhed, in March, 1793, in the Annales de Chimie, tom. XVI. an analyfis of the human brain, and of that of feveral of the mammalia, of which I fhall here prefent a notice.

5. The human brain, which I fhall take as the example and type, frefh and cut into flices, placed in a flafk with a tube, immerfed under a bell glafs full of water, at 20 degrees of temperature, give out at firft fome bubbles of carbonic acid, but it afterwards prefented no gas during more than a year; it exhaled a bad fmell without experiencing any real fermentation, or very perceptible alteration in its fubftance, &c.

Expofed to the air, at a temperature exceeding 12 degrees, the brain becomes very fetid, affumes a green colour, putrefies, but neverthelefs

thelefs acquires acidity, and reddens blue paper.

Dried on the water-bath it firft coagulates, a fmall quantity of water is feparated from it, and it diminifhes from $\frac{4}{5}$ to $\frac{7}{8}$; it grows lefs, becomes yellow; it kneads and balls under the fingers. When afterwards ftrongly heated in an earthen crucible, it exhales ammonia, foftens, fwells, becomes brown and black, melts, diffufes thick and acrid fumes, inflames, remains for a long time ignited after the diminution and ceffation of its flame; it then affords fulphureous acids, produced by the combuftion of the fmall quantity of fulphur which it contains, melts in this feemingly coally ftate, acquires a ropy liquidity, becomes fixed into a fort of blackifh and brittle bitumen, and affords no trace of alkali in its lixiviated coal. When the dried brain is treated in the retort, we obtain from it water charged with feveral ammoniacal falts, a confiderable abundance of oil, concrete carbonate of ammonia, carbonated and fulphurated hidrogen gas, and carbonic acid. We find fome traces of phofphates of lime and of foda, but no free in its coal.

6. The cerebral pulp diluted with water, and fufpended in it like a thick emulfion, is coagulated by heat, and feparates into flakes like milk treated with an acid. The liquor, feparated from the flakes, is precipitated by lime-water and by the calcareous falts; it becomes coloured as it evaporates; it affords phofphate

of soda by crystallization. All the brains of the mammalia and birds present the same character of being diluted in water by trituration, and separating from it in coagulated flakes by the action of heat. This viscus and glairy solution froths by agitation, and resembles a strong ley of soap so nearly, that it might be mistaken for it by its appearance. A part of this cerebral matter suspended in the emulsive form, swims like a kind of cream at the surface of the liquor. Alcohol coagulates and precipitates, in condensed flakes, the matter of the brain thus diluted and suspended in water. It is also to be observed, that this liquor, of an emulsive or saponaceous appearance, does not alter the vegetable colours; the acids decompose and coagulate it. The cerebral pulp, ever after its coction, and the kind of hardness of coagulation, which it experiences to dryness, when heated on the water-bath, after having suffered a portion of this liquid to escape, and having assumed, in the kind of dryness which it acquires, a fawn-colour, whilst it is reduced to a fourth or fifth of its primitive weight, has not lost all its attraction for water; it may still be diluted in it by mere trituration, and presents a yellowish emulsive liquor, which indeed is quickly decomposed, throws down flakes of hardened pulp, and retain only some soluble salts.

7. The brain dried, baked, and even beginning to roast, in the manner of those vegetable sub-

ſubſtances from which oil is obtained by preſſure, being placed betwen two hot plates of iron, and ſubjected to the action of a preſs with a lever a metre in length, and moved by two men, did not yield a ſingle drop of liquid oil. This experiment, indicated by Burrhus, who aſſerted that he had extracted a concreſcible oil, from the dried brain, had no ſucceſs; and there is reaſon to believe, that this author employed brain already altered, either by time, or by the proceſſes to which he had firſt ſubjected it. This property of affording a concrete oil, or rather of having almoſt its whole maſs converted into a concreſcible oil, analogous to ſpermaceti, is however acquired by the cerebral pulp, by means of the gradual putrid decompoſition which it undergoes in buried bodies. This is one of the curious obſervations that were made by Citizen Thouret and myſelf upon the bodies with which the ground of the burying place of the Innocents in Paris, was filled to a great depth. They all preſented in their cranium the maſs of the brain leſſened, contracted, occupying not more than from a tenth to a fifteenth of the volume of this cavity, frequently moving freely within it, of a much firmer conſiſtence than in its natural ſtate, of a blackiſh or dark-brown colour in its interior part. This pulp, thus dried and hardened, preſenting no longer either the external form or the internal appearance of the brain from which it had its origin, was brittle, ſoftened

under

under the finger, was diffufible in water, exhaling a faint difagreeable fmell, and prefented all the characters of an ammoniacal foap. It afforded by the acids which decompofed it a thick, fatty, oily, fufible precipitate, which became fixed into cryftalline laminæ by cooling, was foluble in alcohol, and in fhort, poffeffed many properties analogous to fpermaceti. But it is very evident that this oily matter does not exift ready formed in the brain, and that it is the product of a feptic alteration, which announces indeed, in the cerebral pulp, a greater difpofition than in many other animal fubftances to acquire this form and this character of an adipocirous oil.

8. The cerebral pulp being diluted in water, and mixed with fulphuric acid, coagulates into flakes, which may eafily be feparated from it and obtained upon the filtre. The filtrated liquor contains a fmall quantity of animal oil, which burns, is decompofed, and precipitates carbon by the progrefs of the evaporation. We find in it lime, foda, ammonia, united either in part or wholly with the fulphuric acid that has been added, and free phofphoric acid. The coagulated matter does not prefent the oily characters, but thofe of a concrete albumen.

Weak nitric acid decompofes the brain in the fame manner; the concentrated nitric acid immediately coagulates it, difengaging from it azotic gas, produces confiderable motion, effervefcence, and foam, almoft produces

duces inflammation. It leaves to a coally, ſwelled and voluminous matter, and exhales a mixture of nitrous gas, carbonic acid gas, and ammoniacal gas. We find phoſphate of lime, oxalate of lime, and oxalate of ſoda in the ley, and in the aſhes of the coal obtained by this experiment.

Muriatic acid poured upon the human brain, diluted in water, ſeparates from it coagulated flakes which ſwim at the ſurface. The liquor cleared by repoſe, and ſeparated from the coagulum by the filtre, being evaporated by a gentle heat, affords tranſparent pellicles which blacken at the end of the operation: we extract from it by the ſame evaporation, and by abſorbing the exceſs of acid by means of ammonia, ſoda, lime, and phoſporic acid, united partly with each other, and partly with the muriatic acid. The coagulated and dried part is about a tenth or twelfth of the original weight of the brain employed; it preſents all the properties of a concrete albuminous matter.

9. The leys of cauſtic fixed alkalis act powerfully upon the cerebral pulp. This action takes place even in the cold: much caloric and ammonia are diſengaged. This laſt effect, which is obſerved even upon freſh brains, preſents itſelf even with ſuch as are already acrid. The medullary pulp becomes greyiſh, and ſometimes of a light roſe colour. When its ſolution is effected by heat, it comports itſelf like a ſoap. This effect reſembles what has been ſtated elſe-

where concerning the action of the alkalis upon the animal fubftances in general, and it depends upon the alteration which the albuminous cerebral fubftance experiences at the very moment of the mixture. The opofite effects of oils heated with the fubftance of the brain is fufficiently known, as this is an experiment which is conftantly made in boiling and frying this alimentary fubftance in oil; one part, nearly the half, diffolves and gives to the fixed oil a pretty ftrong confiftence: the other dries, contracts, coagulates, bakes, and affumes a denfity, an agreeable tafte, with an infolubility which it did not poffefs before.

10. The action of alcohol upon the cerebral pulp, deprived of a great part of its water by deficcation, is one of the moft fingular phenomena which this fubftance has prefented to me. When treated four times in fucceffion with twice its weight of well rectified alcohol, and by an ebullition of a quarter of an hour each time, in a mattrafs with a long neck provided with a grooved ftopper, in order that as little alcohol as poffible may be loft, the three firft portions of alcohol decanted boiling, depofited by cooling brilliant laminæ of a yellowifh white colour, lefs in quantity each time; the fourth fcarcely depofited any thing. The cerebral matter loft $\frac{5}{8}$ of its weight; and I obtained in all, by the fpontaneous depofition and by the total evaporation of the alcohol, $\frac{2}{8}$ and a half of needled cryftals, of large plates,

or

or of granulated or more condenſed matter. There were, as is evident, $\frac{2}{8}$ and a half loſt in water volatilized with the alcohol. This cryſtallized ſubſtance, of a fatty appearance, became agglutinated into a paſte under the finger; it did not melt in the heat of boiling water, but was merely ſoftened. At a higher temperature, it ſuddenly acquired a blackiſh-yellow colour, and exhaled during its fuſion an empyreumatic and ammoniacal odour. It had therefore no real analogy with ſpermaceti, which melts between 32 and 35 degrees, nor with the fat matter of putrefied bodies, which melts at 28 degrees; it ſeems more to reſemble the fat lamellated cryſtals contained in the biliary calculi, which do not ſoften even at 90 degrees of Reaumur's ſcale. This latter ſubſtance does not become either ammoniacal or empyreumatic at this temperature, like the cryſtalline cerebral oil extracted by alcohol.

11. I muſt here obſerve that the portion of this concrete oil, ſeparated from the alcohol which had diſſolved it by evaporation in the ſun, and which had formed itſelf into a granulated pellicle at its ſurface, in conſequence of the particles being rapidly attracted towards thoſe placed in the centre; preſented ſome properties modified in a different manner from thoſe of the portion of the ſame oil depoſited ſpontaneouſly by the cooling of this alcoholic ſolution. It was a little more abundant than the firſt, of a deeper yellow colour, having a very marked ſmell

ſmell of animal extract, and a very perceptible ſaline taſte; its ſoft conſiſtence reſembled that of black ſoap; it was diffuſible in water, gave it a milky appearance, reddened turnſole paper, and did not become really oily or fuſible after the manner of an oil, till after it had diſengaged ammonia, and depoſited carbon by the action of fire, or of the cauſtic fixed alkalis; it was therefore a little different from the preceding; which indicates that the cerebral pulp does not aſſume this oily character, by partial ſolution in alcohol, unleſs by an alteration which it begins to experience in its principles and its compoſition. It appears that it undergoes a ſimilar change by merely remaining in cold alcohol; for the brain and its different ſections, the nerves themſelves, the cerebellum, the ſpinal marrow, all matters of the ſame chemical nature as they belong to the ſame anatomical continuity, when immerſed and intirely macerated in alcohol, depoſit at the end of ſome months, ſmall brilliant plates or ſtraws, like cryſtals of boracic acid, which are precipitated, and collected at the bottom of the veſſels which are kept in cabinets of anatomy, as we may ſee in thoſe of the School of Medicine of Paris, and the Veterinary School of Alfort. We are even obliged, from time to time, to renew the alcohol in theſe veſſels, and to clean them in order to expoſe the matters which they contain to view; but it is evident that theſe muſt entirely decay, and that whatever

ever they contain of medullary ſubſtance will be ſucceſſively changed by paſſing into the adipocirous ſtate.

12. I have concluded from theſe experiments, of which I have juſt preſented the reſult, that the medullary pulp is a particular ſemi-concrete albuminous matter, more oxigenated than that which exiſts in the ſerum of the blood, containing no free alkali, mixed with a large quantity of water, which gives it the form and conſiſtence of a pulp, and which at the ſame time contains ſome phoſphates in ſolution; that this ſpecies of matter being analogous to white of egg half boiled or hardened, is not a fatty ſubſtance, nor conſequently an alkaline ſoap, as had been thought; that it is more eſpecially remarkable by its property of paſſing into the adipocirous ſtate by putrefaction, which at firſt acidifies it, by the action of the cauſtic alkalis, and by that of alcohol; that this ſubſtance is immediately ſeparated from the blood by the numerous arteries which enter the cranium, and traverſe the texture of the brain in ſuch quantity, that this viſcus has been conſidered by able anatomiſts as formed of vaſcular extremities intermingled and implicated in tortuous windings. It is almoſt ſuperfluous to add, that the centre of the nervous chords is exactly of the ſame nature with the cerebral pulp, as theſe nerves are only elongations or elongated filaments of the brain.

SECTION

SECTION II.

Of the Nervous Fluid.

13. MOST phyfiologifts admit a very light and very moveable fluid, almoft to be compared with the electric or magnetic fluid, which they believe to flow by the impulfe of the will or of any irritation from within the brain, or the cerebellum, or the medulla oblongata, or the fpinal marrow into the nerves; and the ufe of which they confider to be that of conveying the caufe of motion and fenfation. They cannot, however, give any other proofs of its exiftence than the diminution or ceffation of the nervous action in confequence of ligatures applied to the nerves, or of a compreffion which they imagine muft impede or ftop the motion of this fluid. There is no cavity in the nervous chords; we fee in them no other matter than the medulla which occupies their centre, and a mucous liquor which moiftens their membranes. This difficulty vanifhes with thofe who reprefent this fluid as poffeffing a tenuity fuperior to that which is known in any of the vifible animal fluids: it not only efcapes our fenfes, but the imagination itfelf can fcarcely comprehend its velocity.

14. In

14. In admitting this fluid, it muft be fuppofed to have either two oppofite kinds of motion, which is difficult to be conceived in the fame nerves; or elfe two kinds of nervous channels, the one carrying the fenfitive fluid from the organs of the fenfes affected from without into the brain, the feat of the *fenforium commune*, the others conveying it from the brain into the vifcera and the mufcles, in order to carry into them the principle of life and of independent motion, which is fupported in the former, and the command of the will which folicits and provokes it in the latter. It muft moreover be admitted, that this nervous fluid can follow only a fingle courfe, whether in one o in the other of thefe channels, for it cannot return againft itfelf, and confequently, it would appear to be diffipated after its effect has been produced, which accords with its extreme tenuity and the great velocity of its motion. It is undoubtedly on account of thefe difficulties that fome phyfiologifts have denied the exiftence of that fluid which others had called *animal fpirits*, and that they have thought they could explain the functions which were attributed to it, either by a rapid impulfe communicated to an uninterrupted globular texture in the brain and the nerves, or by a vibration excited on the filaments of thofe organs. In fact, thefe two hypothefes are attended with no lefs difficulty than that of the exiftence of a fluid, fince they fuppofe a tenfion, a rigidity, or folidity in

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the nervous fibres, which the moſt ſimple obſervation leads us to reject.

15. No experiment, nor fact, can throw the ſmalleſt light upon or give the moſt ſimple notion of the nature of the nervous fluid. It is intirely and perfectly unknown to thoſe who admit it, and who have no doubt of its exiſtence. It has been ſuppoſed to be the ſame with the electric fluid, but the nerves exhibit no ſign of electricity; and though ſome experiments ſeem to prove, that after death they are very good electric conductors, none can lead us even to ſuſpect its exiſtence in the nervous ſyſtem, and its paſſage, as well as its accumulation in the different regions of that ſyſtem. To admit, ſince the diſcovery of Galvani reſpecting metallic irritation, a particular fluid different from the preceding, of which the brain ſhould be the reſervoir, and the nerves its different ducts, would be the fabrication of an hypotheſis deſtined to be inceſſantly overturned by new reſearches. Some have ſuppoſed the nervous fluid to be a gas, more eſpecially oxigen gas; but it would require hollow tubes to conduct it, and nothing of this kind is known either in the brain or in the nerves. It muſt therefore be admitted, that we are abſolutely ignorant of what the nervous fluid may be, as well as of the general mode in which the action of the brain and of the nerves conſiſts.

SECTION

SECTION III.

Of the Fluid of the Ventricles of the Brain.

16. IN the ventricles of the brain, as well as between its membranes and its furface, is found a flightly vifcous fluid, which inceffantly exudes from the arterial extremities, which lubricates and foftens the furfaces between which it exifts, and prevents them from forming adhefions with each other, as is alfo found in all the other cavities between the furfaces of the membranes of the body. Authors improperly call it a vapour. It is inceffantly fucked up by the abforbent veffels, or by the veins. It fometimes accumulates and forms dropfies of the head of different kinds. A fimilar liquid exifts in the middle cavity of the fpinal marrow and between its membranes. This humour does not appear to differ from that which lubricates all the membranous cavities of the human body in general, and of which I have already fpoken. It is a mucofo-gelatinous liquid, more or lefs albuminous, and containing fome faline matters. It is the fame matter which filtrates between the fibrous fafciculi of the cerebral medula, and renders them foft and pulpy.

Section IV.

Of the Pineal Concretions.

17. EVERY anatomiſt knows that the pineal gland, the uſes of which are abſolutely unknown, frequently contains in the interior of its pulp, two or three ſmall hard concretions, which are found in it by cruſhing this glandular body between the fingers. Theſe concretions are ſo common, that very few brains are opened in the anatomical theatres in which they are not met with. They are generally ſo ſmall and ſo light, that it is neceſſary to collect ſeveral of them together, in order to be able to examine them. About twenty of them are required to form a gramme. They are irregularly rounded bodies, with aſperities and points at their ſurface, never ſmooth and poliſhed. I have found them to be compoſed of phoſphate of lime united to about one third of their weight of gelatinous matter. As the calculi of the pineal gland are ſo frequent in the human brain, and as they do not appear to produce diſeaſes, they may be conſidered almoſt in the light of natural concretions, or depoſitions, the formation of which, in this ſingle region of the brain, is indeed a ſingular phenomenon, the cauſe of which deſerves to be inveſtigated by anatomiſts.

ARTICLE XIV.

Of the Liquids peculiar to the Eye; of the aqueous, vitreous and cryſtalline Humours, and of the Tears.

1. THOUGH I here indicate in particular, as humours of the eye, thoſe only which are known by the name of aqueous, vitreous, and cryſtalline humours, and tears; this admirable organ contains alſo ſeveral other liquid, ſoft, or ſolid ſubſtances, which would deſerve a particular examination, but with which chemiſtry has not yet been occupied. We are entirely ignorant of the nature of the black *pigmentum;* of the choroid, which appears to be carbon; of the ſoft and tranſparent pulp of the retina, the principal ſeat of viſion, and which is certainly not a ſimple albuminous humour, as its aſpect ſeems to announce; of thoſe hard and thin membranes which form the ſhell of the eye; of that brilliant, pearly, gold-coloured lining which inveſts the internal ſurface of the globe of the eye. We have ſcarcely yet occupied ourſelves, or to ſpeak more properly, we have as yet only ſome preliminary, and as it were proviſionary notions of the vitreous, aqueous, and cryſtalline humours, according to the experiments of Petit and Chrouet, who have publiſhed a Diſſer-

tation

tation upon the humours of the eye. The tears are a little better known.

2. The aqueous humour is contained, in the proportion of from a quarter to a third of a gramme, in the two chambers of the eye, the anterior and the poſterior, between the ſurface of the tranſparent cornea and the cryſtalline humour. It is ſeparated by the arteries of the ciliary proceſs and of the iris; it runs out in part by the pores of the cornea, where it is taken up again by the abſorbent veſſels. Its renovation is ſo prompt, that after it has been evacuated in the operation of the cataract by the aperture made in the cornea, it is renewed and diſtends this membrane within twenty-four or thirty-ſix hours. Halloran has ſeen a gramme and one-third of it flow in twelve minutes from a wound in the eye. Bertrandi thought it was lighter than water, in the proportion of 975 to 1000; but there is reaſon to believe that this is an error. It is perfectly tranſparent, has a ſlightly ſaline taſte, and a very great liquidity. It evaporates intirely and without reſidue. The acids and alcohol do not effect its coagulation; the nitric acid, the nitro-muriatic acid, and eſpecially the oxigenated muriatic acid, have the property of rendering it a little turbid. Though little charged with animal matter, it putrefies and exhales a bad ſmell. We find in it alſo ſome traces of alkaline phoſphates, of ſoda, and of muriate of ſoda. Its uſe is to diſtend the cornea and ſupport its rounded form,

and

andretain the cryſtalline and the vitreous humours in their poſition. It ſometimes accumulates to ſuch a degree as to puſh the cornea before it in a hideous manner in the hydrophthalmia: it is ſeemingly gelatinous in the tortoiſe and in ſome fiſhes.

3. Scarcely any thing has yet been ſaid concerning the nature or the compoſition of the vitreous humour; it derives its name from its tranſparency and its aſpect, which reſembles melted glaſs. Incloſed in membranes, or very cloſe membranous cells, it occupies all the bottom of the globe of the eye from the poſterior ſurface of the cryſtalline to the ſurface of the retina; it is ſlightly reddiſh in the fœtus, and is never known to become opaque in old age. The exact degree of its denſity is not known; but it is known to be ſuperior to that of the aqueous humour, and inferior to that of the cornea. Wintringham found it relatively to water, as 10024 to 10000. Its quantity is conſiderable, for, according to Petit, who has given both in the Memoirs of the Academy of Sciences, of Paris, for 1728, and in particular letters, an exact deſcription of the parts and of the humours of the eye, it conſtitutes of itſelf more than two-thirds of the weight. Some of its chemical properties have been indicated by Petit, Chrouet, Mauchart, and Zinn. It does not coagulate in boiling water; it is evaporated intirely by the fire; it contains but very little ſalt and earth; the powerful acids and the fixed alkalis

alkalis render it a little turbid. It becomes glutinous, thick, even concrete, and more or lefs opaque in fome difeafes, efpecially in the glaucoma. Duhamel faw it once fenfibly reddened in an animal to which he adminiftered madder.

Boerhaave obferved already long ago, that a wound made into the vitreous fubftance fuffered the humour of this fubftance to run out only in a fucceffive, gradual manner, drop by drop, whence he concluded that this humour was contained in numerous cells communicating with each other, narrower in the interior and wider at the outer part of this body, to which its apparent vifcidity is owing; for when we fufpend a vitreous humour by a thread over a veffel, in proportion as the humour runs out, the fmall divifions of the membrane contract, difappear by approaching each other, and the liquid collected is as thin and as fluid as water.

4. The cryftalline lens, feated in the anterior foffa of the vitreous fubftance, and inclofed in its particular capfule, is an almoft folid or femi-concrete body, like a very thick jelly, of a lenticular form, the form, the curvature, and the internal ftructure of which have been carefully inveftigated and defcribed. It has a diameter of about four lines in man, and the average amount of its weight is a quarter of a gramme. It is heavier than water, and finks to the bottom of this liquid. Very foft in the fœtus, it grows hard in old perfons, and by the

progrefs

progrefs of age it gradually paffes from a perfectly colourlefs and tranfparent ftate into a yellowifh colour, like topaz or amber, with a flight obfcurity. It is very eafy to be cut or divided; preffure bruifes and extends it, and feparates the greater part of its particles.

It has long been known that it is fufceptible of becoming opaque, cartilaginous, offeous, and even of an almoft ftony hardnefs. The example of fried fifhes fhows us that the cryftalline lens becomes concrete by the action of heat; that it is rendered white and friable, like a kind of foft plafter; that it feparates into concentric plates, which are eafily divided into a hundred; and that thefe plates are formedof fibres intertwifted, or rolled up in fpiral windings.

Chrouet, in his hiftory of the humours of the eye, affures us that the cryftalline affords oil and ammoniacal fpirit in great abundance by the action of fire. Twenty-four grammes of this body diftilled, afforded him two grammes and a quarter of infipid water, eight grammes of ammoniacal water, a third of a gramme of concrete carbonate of ammonia, a little lefs than three grammes of very fetid oil, and eight grammes of coal, the incineration of which left a gramme and a half of afhes without fixed falt or alkali.

The cryftalline becomes opaque by coction in boiling water, by the action of the acids, and by alcohol. It feems to be formed of a thick, albuminous

albuminous and concrefcible matter with a portion of gelatin. No exact analyfis has yet been made of it.

5. The tears are fecreted by a conglomerate gland, fituated in a depreffion at the external and fuperior angle of the orbit, and they are difcharged by fix or feven open ducts in the conjunction over the margin of the upper eyelid, whence they flow along the eye towards the puncta lacrymalia. They have not been the object of a connected feries of refearches. They had been reprefented as a rather faline aqueous liquor, affording fcarcely any refiduum by evaporation; and Pierre Petit, in his curious treatife on the tears, being intirely occupied with their origin and their relations with the paffions, had fcarcely faid any thing concerning their nature. The illuftrious Haller complained of this want of facts in his great phyfiological work; he contented himfelf with quoting fome rare examples of faline cryftals which they had exhibited to Bruckman, of thofe of an auftere acid tafte, which Schaper had obferved in an ophthalmia of the blood which frequently is mixed with them, of the fweet quality which had been found in them in fome difeafes. Several fortunate opportunities for procuring them having prefented themfelves to Citizen Vauquelin and myfelf, in 1791, we made them the particular object of our refearches; and we have publifhed upon the Analyfis of this humour, in the

Annales

Annales de Chemie, for Auguſt of the ſame year, a Memoir of which I am now about to preſent the reſults.

6. We procured tears in ſufficient abundance to be able to make them the ſubject of our experiments, either from perſons ſubject to weeping, who conſented to collect them in ſmall glaſs veſſels, or by cauſing them to flow in unuſual abundance, by means of mechanical irritation applied to the noſtrils, or by the effect of cold, which increaſes their diſcharge in ſome individuals. This humour is as clear as water, without ſmell, of a ſaline taſte, and of a weight little ſuperior to that of diſtilled water. It turns the paper tinged with mallows or violets green, without this colour being diſſipated in the air; a proof that it proceeds from the action of a fixed alkali. When heated, it preſents at its ſurface many permanent bubbles, like a mucous liquor; evaporated to dryneſs, it leaves at moſt 0,04 of a dry and yellowiſh reſiduum of an acrid taſte. In cloſe veſſels it affords much water, ſome traces of oil and of ammonia, and a very ſaline coal. The incineration of the product of the ſpontaneous evaporation exhibited to us muriate of ſoda, carbonate of ſoda, very little phoſphate of ſoda and phoſphate of lime.

7. Tears expoſed to hot and dry air, in a flat veſſel, become thick pretty quickly; they become viſcid and ſtringy, without loſing their tranſparency; aſſuming a yellowiſh and ſome- times

times a green colour. They afford cubic cryſtals, which alcohol diſſolves without attacking the mucous and thick part; theſe cryſtals turn paper ſtained with mallows green, and announce an exceſs of alkali. Water which diſſolves immediately, in every proportion, and dilutes the lacrymal humour in its natural ſtate, does not operate in the ſame manner upon this humour when thickened and become ſtringy by expoſure to the air. It remains ſuſpended in the water like a glairy matter, or elſe diſſolves very ſlowly; for the water froths by agitation, after having remained a long time upon this matter. This is an inſtance in which the contact of the air deprives an animal matter of its ſolubility in water.

The alkaline ſolutions, which have no ſenſible action upon the pure tears, quickly diſſolve tears that have been thickened by expoſure to the air, and reſtore them to their original fluidity and tranſparency.

Lime-water, the ſolutions of barites and of ſtrontian, produce no effect upon the tears at the moment of their diſcharge; but when they have been for ſome time expoſed to the air, they render theſe liquors turbid, and afford very ſenſible precipitates of earthy carbonates. This phenomenon proceeds from the circumſtance that the tears contain a ſmall quantity of pure ſoda, which attracting the atmoſpherical carbonic acid, and paſſing gradually by the contact of the air into the ſtate of alkaline carbonate, becomes

comes thus ſuſceptible of being decompoſed by the ſolutions of the three earths, whoſe attraction for carbonic acid is ſtronger than that of the ſoda. Alcohol forms very ſenſible white flakes in the tears, and retains the moſt of their ſalts in ſolution.

8. No acid has any action upon the tears at the moment of their diſcharge, when they have not yet experienced any alteration. No other change takes place in them, than the ſaturation of the ſoda which they contain: ſo that the ſmalleſt quantity of acid is ſufficient to prevent their turning the mallows-paper green. The reſiduum of their ſpontaneous evaporation comports itſelf differently with the acids. A drop of concentrated ſulphuric acid thrown upon this reſiduum produces a very ſenſible effervefcence, accompanied with a white vapour; muriatic acid and carbonic acid are diſengaged at the ſame time, which announces the decompoſition of the muriate of ſoda contained in this fluid, and of the carbonate of ſoda which is formed in it by expoſure to the air. The muriate and acetous acids, on the contrary, produce only a ſlight effervefcence with this ſpontaneous reſiduum of the tears, becauſe they decompoſe only the carbonate of ſoda, and diſengage only the carbonic acid.

9. The oxigenated muriatic acid is one of the re-agents that have given us the moſt light reſpecting the nature of the tears. We already know

know from a fact, which cannot escape our observation in active laboratories, that the contact of the oxigenated muriatic gas thickens the lacrymal humours to such a degree, as to render the motion of the eye-lids upon the ball of the eye difficult and painful. When liquid oxigenated muriatic acid is poured upon tears at the moment when they have been discharged from the eye, a slight coagulation takes place in this liquid; flakes are precipitated, at first white, which are quickly turned yellow by a larger proportion of acid. In proportion as they are formed, the oxigenated muriatic acid loses its harsh smell; whence we see that it yields its oxigen to the animal matter. It cannot be doubted, that what here takes place rapidly, is effected in a gradual manner upon the tears by the contact of the air; that in both cases the fixation of the atmospheric oxigen is alone to be considered as the cause of the thickening and the formation of a white and seemingly puriform matter, which takes place in the nasal sac, when the tears remain in it, obstructed by any impediment. A slight compression, to the application of which persons subject to obstructions of this sac are incited by an itching sensation, causes this thick yellowish matter to issue out from the puncta lacrymalia, in small cylinders or elongated drops, more or less solid, moulded by the branches of the lacrymal syphons. We must add indeed to this action of the atmospheric oxigen, the evaporation of the

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the water as a caufe of this thickening; for we were convinced by a fubject afflicted with an obftruction of the nafal fac, that he could extract four times as much humour from this diftended fac by preffing it out every hour, than by foliciting its difcharge every four hours. The fame infpiffation, proceeding from the abforption of the air by the tears and the evaporation of their water, gives rife to thofe fmall clots of thick, yellowifh, and concrete humour, which are formed during fleep, round the lacrymal caruncles.

10. It refults from this analyfis that the tears are formed of a large quantity of water, which holds in its folution an animal mucilage, not albuminous, becaufe the fimple acids do not coagulate it, but of a gelatinous nature, and feveral faline fubftances, muriate of foda, pure foda, phofphate of foda, and phofphate of lime. The two laft are lefs perceptible than the two firft. One of the characters that moft eminently diftinguifh this animal matter, is the property which it poffeffes of rapidly abforbing oxigen, and of forming thick, concrete, infoluble flakes. Though it contains the muriate and the phofphate of foda in but fmall quantity, the firft is neverthelefs fufficient to give this humour a faline tafte, and enable it to depofit fome faline cryftals on the outfide of its ducts, as fome rare obfervations have fhown.

The phofphate of lime, of which we have found only fome flight indications in the tears,

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may, it appears, increafe in its proportion under certain circumftances, and feparate in the folid form: it is this which gives rife to the calculous concretions which are fometimes formed in the lacrymal glands, and are even depofited in fmall feparate grains round this gland. I have twice had occafion to analyfe this concretion, and have found its folid bafe to be calcareous phofphate.

Article XV.

Of the Nafal Mucus

1. THE name of *nafal mucus*, is given to a liquid which is fecreted in the cavities of the nofe, and is difcharged outwardly, either by the noftrils in the form of drops, or in that of maffes more or lefs thick and vifcid, or by the fauces, when it defcends by the pofterior part of the nafal cavities in which cafe it is thrown out by hawking and fpitting. This liquid is feparated from the blood by the arteries, with which the whole fchneiderian membrane is provided, and appears to be formed in particular glandular crypts, which we find abundantly diffeminated in the noftrils; it is collected alfo from all the frontal finufes, from thofe of the ethmoid, of the fphenoid and of the fuperior maxillary bones, upon the membraneous fides of

of which we ſee no glanduliform crypts. It is alſo mixed with the lacrymal juice, which deſcends by the channel which paſſes through the os unguis, and dilutes the thickened naſal mucus.

2. We muſt particularly conſider both the abundance and the characters of this liquid in the catarrh, improperly called catarrh of the brain, in which the naſal mucus is ſeparated in larger quantity, and remains a longer time in its ducts. It is eſpecially under this circumſtance that Citizen Vauquelin and myſelf have examined it, as we then procured it with great facility. We have alſo availed ourſelves of the conſiderable diſcharge of mucus which is produced by the contact of the oxigenated muriatic acid gas, in order to obtain a ſufficient quantity of it for the experiments adapted for making us well acquainted with its nature. It has ſeveral times happened to Citizen Vauquelin, who is very ſenſible to the action of the oxigenated muriatic acid gas, that he has collected by its effect ſixty-four grammes of this liquid in leſs than an hour. By means of theſe circumſtances we have been enabled to determine its nature in a conſiderably exact manner. It is known that this liquid is very abundant in children, that it is a little heavier than water, and adheres to moſt bodies, even the moſt poliſhed.

3. The naſal mucus is at firſt liquid, clear and limpid, a little viſcid and adheſive, without

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ſmell, of a ſaline and acrid taſte, which irritates the moſt delicate part of the ſkin: it is then really the pituita vitrea of the ancients. When expoſed to the air and to the fire, it comports itſelf in the ſame manner as the tears, from which it differs only by the abundance of its reſiduum which is thicker, and frequently more coloured. It affords cryſtals of muriate of ſoda, of ſoda in the ſtate of carbonate and of phoſphates of lime and of ſoda; the laſt are much more abundant than the others. It turns paper ſtained with mallow-flowers green, by its ſalts; we alſo find in it an animal matter which is not albuminous, but quickly becomes thick and concrete by the oxigen of the air and of the oxigenated muriatic acid; it then acquires opacity, and a yellow or greeniſh colour, ſwells conſiderably, and becomes filled with bubbles by the action of fire, leaving but little reſiduum upon the ignited coals. This animal mucilage, which is more abundant than in the tears, appears to be of the ſame nature in both.

4. This liquid, being always expoſed to the air which continually paſſes through the noſtrils, is conſtantly thicker, more viſcid and more adheſive than the tears; and the carbonate of ſoda which it contains, whilſt the latter contain only ſoda, announces that the air depoſits in it a part of the carbonic acid which it contains, eſpecially as it is expired out of the lungs. Conſequently, it then renders the ſolutions of barites, of ſtrontian,

ſtrontian, and of lime, very ſenſibly turbid. In the noſtrils, the heat of the plant, eſpecially in catarrhs, and the current of air which inceſſantly acts upon it, contribute alſo to thicken it. The mucilage of the naſal humour, when it becomes thick in the air, frequently aſſumes in it the form of ſmall, dry brilliant, and as it were, micaceous plates. If it has dried in very thin layers, it nearly reſembles thoſe brilliant and light marks which ſnails leave behind them upon the ſubſtances over which they crawl. The naſal mucus experiences no real putrefaction in the air; we ſhould almoſt be induced to ſay that it was unalterable and imputreſcible, when we ſee it remain without contracting any bad ſmell, even in the midſt of water, and at a conſiderably elevated temperature. However, this property of preſervation does not extend ſo far as to communicate itſelf to other bodies that are immerſed in it.

5. Water does not diſſolve the mucus of the noſe. It is known that this matter remains viſcid in that fluid, and that it cannot be diluted water without much difficulty, even by agitation. Hot water and ebullition do not render this ſingular mixture more miſcible or more ſoluble. In boiling water, it appears at firſt to form one body with the water; nevertheleſs we ſee it ſeparate and fall to the bottom of this liquid by cooling. It is probable that this inſolubility is owing to the fixation of the oxigen. Neither has it the property of ren-

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dering oils miſcible with water, nor of effecting their ſuſpenſion by trituration, as a vegetable mucilage does. It is on this account that when we waſh, or even boil this thick humour in water, the ſalts which it contains are diſſolved and ſeparated, without affecting the mucilage which conſtitutes its baſe.

6. The acids thicken the naſal mucus when they are concentrated and employed in ſmall proportions; but when we add a larger quantity, they re-diſſolve and give it different ſhades of colour. The ſulphuric acid tinges it purple, and renders it very liquid, forming however ſome flakes in it which ſink to the bottom. The nitric acid, when rather ſtrong diſſolves it of a yellow colour. The muriatic acid is that which effects its ſolution the moſt eaſily and the moſt completely of all, giving it a violet colour. The alkaline or earthy ſalts do not cauſe it to undergo any alteration, nor do they diſſolve it.

7. The mucus of the noſtrils being eſpecially diſtinguiſhed from all the other animal liquids by the viſcid mucilage which it contains in conſiderable abundance, it is evidently from the preſence of this principle that we ought to ſeek its uſes and the function which it performs in the animal economy. Beſides the kind of evacuation, ſometimes very abundant, which it procures, and the proportion of the evacuated matter compared with that of the other excretory organs, which it carries out of the body, this liquid

liquid maintains the softness of the membranous sides of the nasal cavities and prevents that dryness which the air passing in continual streams through these cavities tends to produce in them. It moderates the too great sensibility of the nervous papillæ which are spread out upon the olfactory membrane; it stops and fixes the odorous bodies, it blunts their too great activity; it purifies the air that is respired, by taking from it the pulverulent particles which it carries along with it, and which would be more hurtful in the lungs. Being always contained in a hot humid, and arid place, three circumstances which would so eminently promote putrefaction, provident nature has given it a property which opposes the septicity which would have exposed man and the animals to a multitude of dangerous vitiations and maladies.

8. It is known that the mucus of the nostrils is capable of changing its nature and assuming various properties in the nasal affections. It thickens, becomes yellow, orange coloured, or greenish, frequently tinges linen with a very lively green cast by drying upon it; it sometimes produces the sensation of the presence of copper; and sometimes it exhales a nauseous or fetid smell. In some affections it becomes so acrid that it seems to corrode the membrane of the nostrils, and produces excorrations round their orifices as well as upon the upper lip. Lastly, it is sometimes liquid like water, at others ropy like oil; in several cases thick, viscid,

viſcid, and always tranſparent like jelly; in other circumſtances, ſemi-concrete and white, yellow or green, like a purulent humour. None of theſe changes have yet been chemically examined, and hardly even has the attention which they deſerve been beſtowed upon them.

9. Citizen Vauquelin and myſelf have deſcribed with much care the effect which the oxigenated muriatic acid gas produces upon the naſal mucus and upon the membranes which it covers and from which it filtrates. At the very moment when this gas penetrates into the noſtrils, it produces in them a ſenſation of contraction and of uneaſineſs, of which ſneezing is the conſequence; a conſiderable diſcharge of clear liquid is excited. The contraction and the rigidity of the membranes of the noſe and of the throat remain for a long time: after the ceſſation or diminution of the firſt diſcharge, follows an uneaſineſs and ſtuffing of the noſe, and the ſenſes of ſmell and taſte are loſt. An humour, thick, and even dry like parchment, is felt in the noſe and in the fauces: an acrid heat propagates itſelf into the breaſt and produces a febrile commotion: a conſiderably violent head-ache, and confuſion of intellect accompany this ſtate. At laſt white or yellow concrete maſſes are diſcharged by the noſtrils or the mouth, the diſcharge of which laſts ſeveral hours, procures relief, and the malady gradually ceaſes till the equilibrium is intirely re-eſtabliſhed. It

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cannot be doubted that this artificial difeafe has a great analogy with the natural catarrh, and that in the production of that difeafe the atmofpheric oxigen exerts an action fimilar (excepting that its intenfity is lefs) to that of the oxigenated muriatic acid. In the fudden fharp frofts which are perceived by a harfh rough fenfation, this principle of the atmofphere acts very quickly upon the nafal mucus; it thickens it by depriving it of water and becoming itfelf fixed; it irritates the furface of the fchneiderian membrane; it evaporates, in the compound ratio of its motion and its denfity, a large quantity of water. This explanation of a natural fact, to which we have been conducted by a phenomenon created by art, fhows what may be hoped from the refearches of modern chemiftry, and how important it is to purfue them without intermiffion.

Article XVI.

Of the Mucous Humour of the Mouth, of the Humour of the Tonſils, of the Saliva, of the Salivary Calculus, and of the Tartar of the Teeth.

1. THE cavity of the mouth, from the margins of the lips to beyond the velum pendulum of the palate, and as far as the upper part of the pharynx, is conſtantly moiſtened by ſeveral liquids which have their ſource in different glandular and ſecretory organs, whoſe seat, form, ſtructure, excretory ducts and functions have much occupied anatomiſts and phyſiologiſts. Very numerous mucous crypts and granulated pellicles occupy the whole ſurface of the tongue, and eſpecially of the infralingual cavity, of the buccal and palatine membrane or of the glandular expanſion of Morgagni, of the alveolar arches, and pour into this cavity an humour ſomewhat leſs thick and mucous than that of the noſtrils, which maintains on all the ſides of the mouth a continual ſoftneſs and lubricity, adapted to facilitate their motion, to enable the alimentary bole to ſlide down, and to prevent that thirſt which dryneſs of theſe parts, from whatever cauſe it may ariſe, conſtantly produces. This kind of mucous and lubricating humour have

have never been examined in particular, nor could it, either becaufe it is not fufficiently abundant to be collected feparately, or becaufe it is always mixed with the falivary humour and the humour of the tonfils which inceffantly flow into the mouth. For the reft, it does not appear to be in any refpect different from the humour which is fecreted in all the cavities in order to lubricate them, and of which we have already treated.

2. The tonfils, organs very fingular in their form and their fungous ftructure, placed on both fides of the throat before the paffage of the alimentary bole, and between two membranous columns which fupport the velum palati, inceffantly difcharge into the pofterior fauces, by the numerous crypts and pores with which their whole furface is covered, a fomewhat thick and glairy humour, which is frequently feen about them when they are viewed with attention, and which we feel detach themfelves like fmall gluey maffes by the rapid motion which is communicated to the air in the action of hawking. It is believed that this humour, the quantity of which muft be pretty confiderable from the fize of the organs which furnifh it, is of the fame nature with that of the crypts, and that of the glands of the mouth. No particular examination however has been made of it, and we ftill judge of it only by the analogy of its place of ftructure and its ufes.

3. The

3. The ſaliva, properly ſo called, ſeparated from the blood in the parotids, the ſubmaxillary and ſublingual glands, poured into the mouth by the ducts of Stenon from the firſt, of Warthon from the ſecond, and of Rivinus from the third, has been, if not analyzed with much attention, at leaſt ſufficiently examined by Vieuſſens, Pott, Nuck, Barchuſen, Verheyen, Boerhaave, and Haller, to be better known than the preceding liquids. Haller, in his great phyſiological work, has collected all that phyſiologiſts had obſerved before him. I have added ſome facts to thoſe which had been indicated by the authors abovementioned. Citizen Michel de Tennetar has deſcribed ſome phenomena which this humour preſents in acting upon the metallic ſubſtances. Citizen Lachenaye has given a ſufficiently detailed analyſis of the ſaliva of the horſe; but none of theſe chemiſts has announced more experiments, or a more concluſive ſeries of inquiries, than M. Siebold, who publiſhed, in 1797, at Jena, a ſufficiently detailed diſſertation in quarto, upon the ſalivary ſyſtem, conſidered in a phyſiological and pathological point of view. I ſhall borrow from theſe different authors, as well as from my own obſervations, what I am about to ſay concerning this humour.

4. The ſaliva is a ſlightly viſcous liquid, ſtrongly characterized by its frothy ſtate, its inſipid and partly ſaline taſte, its want of ſmell, its

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ſweetiſh odour, and its white colour mixed with a blueiſh caſt. Its weight is to that of water, according to Haller, as 1960 to 1875, and according to Mr. Siebold, as 1080 to 1000. The proportion of its conſiſtence, or of the coheſion of its molecules to that of water, as 30 to 10. Mr. Siebold, in order to define this conſiſtence in a more perſpicuous manner, ſays that it reſembles a mixture of one part of gum and forty parts of water. It is neither acid nor alkaline: it does not change the natural ſtate of any vegetable colour. Brugnatelli aſſerts, that he has found it impregnated with a large quantity of oxalic acid in an emaciated venereal patient, who appeared to him to loſe, by this evacuation, the nutritive and ſaccharine part of his aliment. Its quantity varies greatly. Nuck eſtimates it between 256 and 384 grammes in twenty-four hours. In exceſſive ſalivations, its diſcharge has been to the amount of two or three kilogrammes daily: Turner eſtimates its whole quantity, diſcharged during an entire mercurial courſe, at 60 kilogrammes or 120 pounds. Some authors have aſſerted that the ſaliva carried mercury along with it; but it has never been practicable to extract any from it in the experiments made in the laboratory of the Ecole de Medicine of Paris.

5. The ſaliva, heated or evaporated, leaves but very little reſidue; it ſwells conſiderably, and ſoon dries into ſmall white or yellowiſh, ſaline and acrid plates. When it is evaporated

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to a third of its quantity, and afterwards fuffered to cool and repofe, it affords cryftals eafily diftinguifhable as muriate of foda, by their cubical form, their faline tafte, the muriatic acid vapour which the fulphuric acid difengages from them, and the curdled precipitate which they form in the nitrate of mercury. Gently evaporated to drynefs, the faliva leaves a refiduum like the glutinous matter of flour, which fwells and inflames upon the coals, exhaling a fmell of burned horn or hair. A fmell of Pruffic acid is alfo perceived. When the faliva is fubjected to diftillation in a glafs retort, we fee a froth arife upon it, which occupies a large fpace; it affords all the products of the animal matters, and leaves a coal in which I have found, befides the muriate of foda, phofphates of foda and lime in confiderable abundance. Pruffic acid is alfo very perceptible amongft the products. The proportion of ammonia formed is not larger than in the diftillation of the other animal matters.

6. When expofed to the air, the faliva abforbs a confiderable quantity, and froths much by agitation; at the end of fome hours, according to the obfervation of Mr. Siebold, it prefents a light pellicle, exhibiting the prifmatic colours, and of a fatty appearance at the furface; it foon becomes turbid, and depofits flakes; it exhales a very lively and very pure ammoniacal odour. Macbride believed that there efcaped from it a large quantity of fixed

air:

air: this he particularly concluded from the large volume and the frothy ſtate which it aſſumes in vacuo: it is well known that it is ordinary air which is diſengaged in this experiment. The ſaliva putrefies and becomes very fetid after the ammonia which has formed in it has been diſengaged. This humour, however, has been conſidered, according to the experiments of Pringle, as eminently antiſeptic, and it has been pretended that it checks the putrefaction of meat immerſed in it. Indeed, a greater number of authors have on the contrary ranked it amongſt the moſt powerful ferments, and have particularly deſignated it as promoting the vinous fermentation of the farinaceous ſubſtances; they have even thus explained how the ſavage nations of America and Africa prepare intoxicating liquors with maſticated roots and ſeeds, which they afterwards expoſe to fermentation. This property deſerves ſtill to be better aſcertained by accurate experiments.

7. The ſaliva has long been known to corrode or oxidate iron and copper pretty quickly. It was alſo cuſtomary, in the laboratories of pharmacy, to ſpit in the mortars in which the mercurial ointment was prepared, and it was known that this proceſs accelerated the extinction or the black oxidation of the mercury. Citizen Michel du Tennetar, profeſſor of chemiſtry at Metz, diſcovered, about twelve years ago, that when leaf-gold and leaf-ſilver were triturated

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in ſaliva, the oxidation of both theſe metals, which are ſo difficult to be burned, was effected. It appears that it is ſtill more eaſy to oxide mercury by itſelf in this animal liquor, from a method which has been long practiſed by the Engliſh ſailors, and which conſiſts, according to what I have heard from able phyſicians of that nation, in kneading ſome globules of mercury in the hollow of the hand with the aid of ſaliva, and immediately taking the mercury thus extinguiſhed. By rubbing mercury in ſmall globules adhering to the fingers greaſed, upon the inſide of the cheeks, and as in the method of Clarke, venereal ſymptoms are cured: all theſe phenomena depend upon the ſame cauſe.

8. The ſaliva mixes but imperfectly, and does not completely diſſolve in water; it ſwims at its ſurface, and remains well ſeparated from it. This effect has been attributed to its viſcidity and ſluggiſhneſs; to which we muſt add the little ſoluble nature of the animal mucilage contained in this liquor. Ebullition of the water coagulates ſome flakes in it, and retains the ſaline matters, which it ſeparates from it. The ſtrong acids, in ſmall doſes, thicken the ſaliva, as we perceive in the mouth when we hold an acid liquor in it; in larger doſes they diſſolve it. The fixed alkalies and the earths immediately diſengage ammonia from it. Lime-water, and the ſolution of barites form a precipitate of phoſphate of lime in it; the oxalic acid

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ſhows the preſence of lime by the precipitate which it produces, though it be very ſlight. The metallic ſolutions, eſpecially the nitrates of lead, of mercury, and of ſilver, render the ſaliva very turbid, and produce an abundant precipitate in it: it was eſpecially by theſe means that I found the phoſphates that exiſt in this animal liquid; for theſe metallic precipitates afford very ſenſible traces of muriatic acid and phoſphoric acid both at the ſame time.

9. From all the facts here enunciated it follows that in man, the ſaliva is formed of a quantity of water, which is eſtimated at $\frac{3}{4}$ or $\frac{4}{5}$ of a highly aërated animal mucilage, frothy, almoſt inſoluble or very little ſoluble in water, or of a ſmall proportion of albumen and of ſaline matters, which are muriate and phoſphate of ſoda, ammonia and lime. This manner of conceiving the compoſition of this liquid, beſides that it is the reſult of the experiments hitherto made upon its nature, explains alſo all the phenomena which the ſaliva preſents, its ſemi-coagulation by fire, by the acids, and by alcohol; its difficult ſolution in water, the light flakes which it affords in many caſes, its ſluggiſh viſcidity, its frothy property, and its precipitation by a multitude of bodies. The ſaliva muſt be conſidered as a condenſed ſolution of this viſcid mucilage, which very readily detains the air into which it is immerſed, to carry it into the alimentary bile, and into the ſtomach. The ſalts which it con-

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tains may vary in their proportions, and actually do vary, according to a multitude of circumſtances.

10. It frequently happens that there are formed in the ſtrainers of the ſaliva, and depoſited in the excretory ducts of the ſalivary glands, ſome kinds of concretions or calculi, which have been improperly called ſtones. They have been particularly obſerved in the Warthonian duct much more frequently than in the Stenonian, or that of Rivinus. Haller, after having quoted a multitude of examples from authors, inquires what may be the cauſe that favours this formation in the firſt claſs of theſe ducts rather than in the two others. We are not ſufficiently acquainted with the ſtructure of the different ſalivary glands to be able to pronounce upon the cauſe of this ſingular prerogative of the Warthonian duct. Scherer, in a diſſertation intituled *De calculo in ductu ſalivali,* has deſcribed with great care the maladies which this ſpecies of concretion produces, and all the circumſtances which accompany it. Hippocrates was already acquainted with the ſtone under the tongue. The tumor called *ranula,* and *anginas,* have been known to be the conſequences of this kind of concretion. Many facts have alſo proved that it is ſpeedily formed. I have examined one of theſe ſalivary calculi given me by Citizen Sabbatier, and I found it to be compoſed of phoſphate of lime and of a kind of animal mucilage. Its ſource

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is therefore manifestly in the saliva, which, like all the white and more or less viscid humours, contains phosphate of lime, the proportion of which is sometimes augmented by causes that are hitherto unknown or undetermined. It appears that this augmentation depends, in several circumstances, upon a general cause, and that it takes place in all the humours at the same time, undoubtedly because the ducts which naturally evacuated its superabundance are then too much constricted. In such case, similar concretions are formed in many places, and some are deposited even in the substance of the membranes.

11. Those very frequent incrustations which surround the base of the teeth, and are known by the name of tartar, which loosen and repel them, destroy the gums, and sometimes become so considerable that they separate and displace the teeth themselves in some individuals who take no care of their mouths, are also of the same nature. The saliva, and the other juices of the mouth which incessantly bathe these bones, and remain between the margins of the gums and the teeth, gradually deposit upon them, by a real crystallization, particles of this earthy salt; and it is not to the residue of the aliments, as is commonly believed, that this pretended *tartar of the teeth* is to be attributed. When we examine with a good magnifying glass the tartariform concretion which encircles these bones towards their base

baſe, and which ſometimes extends as far as their alveolae to the ſides of which it attaches itſelf, we find it compoſed of ſmall grains united together and brilliant in ſome points. We perceive in it, by the microſcope, a great number of pores or ſmall polyhedral cavities which reſemble the cells of polypuſes in their form and arrangement. Magellan, the philoſopher who undoubtedly ſaw microſcopic animalcul in it, thought that this concretion was a ſort of nidus of *polypuſes* formed by theſe animals. But it is more natural to believe, that this cryſtalline depoſition of the humours of the fauces, ſimilar to the concretions ſo generally diffuſed and ſo common in the animal economy, receives at its ſurface and in its pores ſome particles of alimentary reſidue, charged, like every ſoft, humid, and warm organic matter, with microſcopic animalcul. The nature of this depoſition upon the teeth is really phoſphate of lime, mixed with a portion of mucous and glairy ſubſtance: accordingly, the acids diſſolve it, as has long been known, by the employment of theſe ſubſtances adapted for cleaning the teeth, upon which indeed the acids act in a dangerous manner if care be not taken to confine their operation merely to the layer of tartar which ſurrounds and covers them.

Article XVII.

Of the Cerumen of the Ears.

1. THE cerumen of the ears, ſo called on account of the conſiſtence of ſoft wax which it commonly has, attracted the attention of the ancient phyſicians much more than of thoſe of the preſent age. The ancient ſchools, as Bourdeu has obſerved, taught that the gall-bladder was purged of this humour of the ears. Hippocrates aſſiduouſly occupied himſelf with the conſideration of it in diſeaſes, and compared its production with the flow of the bile: the moderns have intirely neglected this kind of obſervations; and at the preſent day the analogy, which ſubſiſts between this humour and that ſecreted by the liver, ſeems forgotten. The cerumen, however, poſſeſſes properties ſo remarkable, ſo different from thoſe of moſt of the other animal liquids, that I have thought I ought to aſſign to it a particular article. What does not appear ſtriking to every one at preſent may appear ſo hereafter. This aſſertion is particularly applicable to the matter which forms the ſubject of the preſent article, and of which but very little has been ſaid by any author, even amongſt thoſe who have particularly occupied themſelves with the organ of hearing,

Caſſebohm, Valſalva, Duverney, Schroeder, Le Cat, &c. Haller, who according to the order which he had adopted, exhibits by his vaſt erudition all that the anatomiſts and phyſiologiſts had diſcovered before him, has ſcarcely devoted five or ſix lines to the examination of the diſtinctive properties of the cerumenous humour.

2. This humour is prepared in a particular glandular apparatus diſcovered by Stenon, ſeen by Drelincourt, well deſcribed by Valſalva, Duverney, and Haller. It conſiſts of ſmall round and oval glands, of a browniſh yellow colour, of a very firm conſiſtence, diſſeminated under the ſkin, and placed, either in the excavations of the oſſeous auditory paſſage, or in the cartilagineous portion of this paſſage, eſpecially towards its anterior part. Each of theſe ſmall glands has a very ſhort cylindrical duct, which perforates the epidermis, and opens into the auditory paſſage by an orifice viſible to the naked eye. There runs out from it a ſmall drop of a yellow humour, at firſt a little viſcid like an oil, which quickly thickens in the warm cavity of the ear by the contact of the air, and is converted into a kind of unguentaceous matter, of a deep yellow or orange colour, or even reddiſh, of a very bitter taſte, which inflames when it is heated, as Boerhaave had eſpecially indicated. Pechlin has compared the cerumen to caſtoreum. It had eſpecially been remarked that this humour might, by remaining for

for a long time in the auditory paſſage, thicken in ſuch a manner as to form a ſolid cylinder, capable of obſtructing the paſſage like a real ſtopper, and prevent ſounds from arriving within it; that this thickening, which ſome authors have obſerved as far as concrete and plaſter-like ſtate, was a frequent cauſe of deafneſs, and that it was cured by injecting ſoap-water.

3. Theſe facts comprehend, even in the moſt learned and extenſive works, the whole hiſtory of the cerumen of the ears. Bordeu, who in many parts of the art, wiſhed to revive the notions of the ancient phyſicians, and eſpecially thoſe of the Coan ſchool, contented himſelf with prognoſticating, after having noticed the attention which this ſchool paid to the cerumen, that ſome practitioner might meet with a particular caſe adapted to explain the pretenſion of one of the ancients with reſpect to this ſubject. Nearly thirty years have elapſed during which this ſuggeſtion of an enlightened man has called in vain for obſervations. Whilſt I indulge the hope that phyſicians may beſtow upon the ſubject the attention which it deſerves, I ſhall exhibit ſome ideas reſpecting the chemical properties of this humour, which is difficult to be procured in the abundance requiſite for ſubjecting it to extenſive reſearches. I muſt ſay, that of all the phyſicians whom I have acquainted with the importance which I attach to the examination of this humour, my colleague

league Hallé was the perfon who was moft ftruck with it, and that he fucceeded, by his enlightened zeal for the progrefs of our art, in furnifhing Citizen Vauquelin and myfelf with a fufficient quantity of cerumen to enable us to begin an exact analyfis of it.

4. The cerumen collected during feveral fucceffive months by a healthy individual, with the aid of an ivory ear-fpoon, and kept in a piece of paper, impregnates the texture of the paper like a fat oil rendering it tranfparent, and preventing water from penetrating it. It is eafy to be united and kneaded into a fingle mafs; I have formed an almoft folid ball of it, which was of an orange-yellow colour, nearly without fmell, of the confiftence of foft wax, and of a bitter, difagreeable tafte. When placed upon an ignited coal, the cerumen inftantaneoufly melts; it quickly fwells and exhales a thick fume, the fmell of which is ammoniacal, and of a fenfibly aromatic fetidity; it does not differ much from that of burned horn or hair; it emits very little flame at the end of this operation. It leaves a coal, which has loft the pretty confiderable volume which this matter had at firft affumed, and which is too little abundant to be analyfed: this coal is difficult to be incinerated. We had too fmall a quantity of cerumen to be able to diftil it, efpecially after to the little light which this experiment promifes.

5. The

5. The cerumen triturated with water, in a mortar, dilutes pretty well and diffolves in part. It affords a kind of emulfive liquor, of a yellowifh white colour, in which we fee fmall drops of oil collect at the furface. This is manifeftly the effect of a mucilage holding for fome time an oil in fufpenfion. The matter thus diluted is fufceptible of the putrid decompofition, though the intire cerumen keeps for whole years without any fign of putrefaction; it is, next to the folid or offeous parts, the leaft alterable of the animal matters. Alcohol takes up but very little from it, and is only flightly coloured, even when it is boiled for fome time upon the cerumen: when this coloured alcohol is filtrated and left to cool, a portion of the matter which it had diffolved is feparated fo that the liquid becomes turbid and flightly milky. According to the comparifon of this action of water and of alcohol, the cerumen appeared to us to be an intimate mixture of an animal mucous fubftance with an oily or fatty matter, rendered concrete by the abforption of atmofpheric oxigen. This laft matter renders it fimilar to the bile, to which the ancients had already found it to be analogous.

6. Thus much I, for my own part, was able to afcertain refpecting the cerumen, from the fmall quantity which I had collected from myfelf. Since thefe firft experiments, Citizen Vauquelin, who had undertaken to examine the cerumen with which our colleague, Citizen

Hallé,

Hallé, had furniſhed us, and who having a much larger quantity of it, was able to ſubject it to a more regular ſeries of experiments, gave me reports of them, of which I ſhall here exhibit a ſketch, as it is adapted to extend the notions which I have already given, and to give them ſtill greater preciſion.

The maſs which he had to examine formed a ball, ſome centimetres in diameter, and nearly ſix grammes in weight. This matter is pitchy, of a bitter taſte, of a deep orange colour: put upon a piece of paper and ſlightly heated, it melts, penetrates, and ſpots this texture, rendering it tranſparent, as oil does. It has a very particular, ſlightly aromatic, and ſomewhat acrid ſmell, eſpecially when it is heated and rubbed between the hands.

7. Placed upon an ignited coal, the cerumen ſoftens, and exhales a white fume, which has the ſmell of burned fat; it ſoon melts, ſwells, becomes coloured, and emits an ammoniacal and empyreumatic ſmell. After this action of the fire, there remains a voluminous and rather light coal. Diluted with water, the cerumen forms a kind of emulſion of a yellowiſh white colour, which quickly putrefies and becomes very fetid. Though water does not diſſolve it, it however takes ſomething from it; for, in putrefying, it depoſits whitiſh and mucilaginous flakes. Treated with alcohol, with the aſſiſtance of heat, it communicates to it a ſaffron-yellow colour, and by cooling, ſome white flakes are

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depoſited. Sulphuric ether alſo diſſolves part of the cerumen; and though it depoſits nothing by cooling, it acquires a ſlight colour by remaining ſome inſtants in contact with it, either in the heat or in the cold.

8. Two grammes of cerumen treated with hot alcohol loſt 1,25 grammes, and afterwards weighed only 0,75 of a gramme. The portion not diſſolved, when dried in the air, was tranſparent, brittle, leſs coloured, leſs fuſible by the fire, and exhaled, while it burned more ammonia than oily vapour; the coloured alcohol afforded by evaporation a reſiduum of a pretty dark colour, conſiderably bitter, of a conſiſtence and ſmell reſembling thoſe of turpentine, fuſible without ſwelling, volatilizing into a white vapour of a fatty ſmell, and without leaving any perceptible coal: it had all the characters of a fixed oil.

Two grammes of the ſame cerumen, treated with ſulphuric ether, with the application of a little heat, loſt 1,25 grammes, and weighed now only 0,95. The liquor was leſs coloured than that of the alcohol; evaporated by a mild fire, it left a matter of a pale-yellow colour, of a tenacious conſiſtence like turpentine, of a ſmell analogous to that of this reſin, and leſs bitter than that which had been obtained by the alcohol. The 0,95 grammes not diſſolved by the ether, reſembled the reſiduum left by the alcohol, and exhaled much ammonia upon ignited coals. There is, therefore, a ſtriking reſemblance

blance between the action of alcohol and that of ether upon the cerumen: both take from it a matter of an oily nature, more soluble in the first than in the second of these liquids, and leave an insoluble animal substance.

9. The kind of fatty oil separated from the cerumen by the alcoholic liquids, is fusible, and diffues upon the coals a pungent adipose smell; a little coloured, and it is susceptible of dissolving in the fixed and volatile oils, but with difficulty in cold alcohol; though very completely if we employ a large quantity of this liquid. The leys of fixed alkalies unite with it by mere trituration, and form with it a kind of soap, which does not, indeed, assume either the taste or the consistence of common soap.

As to the matter insoluble both in alcohol and in ether, since it becomes dry and brittle in the air, since it softens and even partially dissolves in water, which afterwards putrefies; since it is capable of exhaling empyreumatic ammoniacal fumes whilst it swells upon the coals, and of dissolving, though imperfectly in the alkalies, these characters manifestly belong to albumen; and what confirms this notion is, that when it is burned in a crucible of platina, it leaves a light coal of an acrid and alkaline taste, manifestly containing soda and phosphate of lime.

10. Besides these two substances, the bases of the cerumen of the ears, it manifestly contains a distinct colouring matter, though it has not yet

yet been obtained ſeparate, on account of the too ſmall quantity which we have hitherto had of this animal product. It appears that this colouring matter is the cauſe of its bitterneſs, and that it is the principle of the cerumen which varies the moſt, ſince in fact the moſt ſtriking differences which are remarked in it relate to its colouration and its bitterneſs.

Citizen Vauquelin has given the following reſult of this maſs. The cerumen of the ears is a compound of three ſubſtances: 1ſt. a fatty oil, more analogous to that which is contained in the bile, than to any other adipoſe animal matter; 2d. an albuminous animal mucilage; 3d. a colouring matter which ſeems to reſemble that which forms part of the bile, by its bitterneſs and its adheſion with the fatty matter.

11. The uſes aſcribed to the cerumen are, to ſoften and lubricate the ſides of the meatus auditorius, to deter inſects from entering into this paſſage, by its bitterneſs, to ſoften and even deaden the ſonorous vibrations of the air, and thus to moderate the force of ſound. There is reaſon to believe, from the oily nature of the cerumen, and its bitterneſs, that it ought to be ranked in the claſs of excretions, and that it evacuates a particular acrid matter. If, as the ancients remarked, its quantity increaſes in ſome circumſtances of diſeaſes, and if its proportion anſwers to that of ſome other evacuations, the obſervations which Bordeu called upon the phyſicians to make, may ſome day afford

afford more light refpecting the ufes of this humour. Haller does not forget to remark, according to Derham, that birds have no cerumen, and that it is found only in thofe animals whofe meatus auditorius is more or lefs elongated. In fact, it is abundant in fome of the mammalia; and it would be of great utility to the art to examine it with care in thefe animals, in order to afcertain its properties and the relations or differences which fubfift between it and that of man.

Article XVIII.

Of the Tracheal and Bronchial Humour; of the Pulmonary Gas, and of the calculous Concretions of the Lungs.

1. BY referring to this article, all the animal matters which belong to the cheft in particular, and which are fituated within the cavity of the thorax, we find a much greater number of thefe matters than I have inferted in this title. In fact, we muft rank in this clafs the tracheal humours, the humour of the bronchial glands, the arterial and the venous blood, the air infpired, the air expired, or the pulmonary gas, the pulmonary tranfpiration, the humour of the pericardium, that of the pleura, the concretions of the lungs, the parenchymatous

tous texture of this viſcus, and the texture of the heart. But amongſt theſe twelve ſubſtances, there are many which are already known, and which have already been treated of in the articles concerning the matters generally diffuſed throughout the whole body. In fact, I have elſewhere ſhown the difference between the pulmonary, arterial and venous blood, and the blood of the other regions. The air inſpired is that of the atmoſphere, which has been examined in detail in the ſecond ſection; the pulmonary tranſpiration has been compared, in one of the preceding articles, with the cutaneous perſpiration of the whole body; the humour of the pericardium and that of the pleura preſent no difference from that of the other internal membranous ſurface; the parenchymatous texture of the lungs, which has been confounded with the cellular texture, has not yet been particularly examined; that of the heart is only muſcular fibre, more denſe than that of moſt of the muſcles. There are therefore to be examined with more detail, only the tracheal and the bronchial humours, the pulmonary gas, or the air evacuated by expiration, and the calculous concretions. I have not even comprehended, in this general enumeration, the humour of the thymus; becauſe, excepting that it has been compared with milk on account of its whiteneſs, its nature is abſolutely unknown. Not the ſlighteſt experiment has been made upon its compoſition and its properties, though this

this object is very interesting, and deserves all the attention of physiologists.

2. The larynx and the trachea are continually lubricated and moistened by a humour which extends throughout the whole continuity of the bronchial, and which covers, lubricates, and softens their internal membrane. This humour is a little viscous and gluey; it is transparent, and of such a consistence, that it cannot flow; for, had it this character, it would incessantly irritate this very delicately sensible passage, and excite a perpetual cough. This humour of the trachea appears to be of the same nature as that which moistens and lubricates all the other cavities or hollow membranes. It is, however, probable, that this liquid has not the same saline character as the saliva, the mucous humour of the mouth, &c. It is known that the tracheal humour has neither taste nor smell. Hitherto it has not been possible to make any particular analysis of it, because it is not easy to procure a sufficient quantity of it for this analysis. Anatomists have attributed the origin and referred the source of this liquid to mucous glands or crypts, situated under the internal membrane of these air ducts; sometimes it is discharged in the form of sputa. It cannot be doubted that, being incessantly in contact with the air which penetrates the bronchial vesicles, this humour thickens, either by the evaporation which it undergoes, or by the action which the atmosperical oxigen gas exer-

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cifes upon it. Some phyfiologifts have erroneoufly attributed to it the blackifh blue colour, of certain flaky matters which are coughed up, and which proceed from another fource, of which I fhall fpeak in the following number.

3. The tracheal humour is confidered as adapted to prevent the drynefs of the internal furface of the larynx, of the trachea, and of the bronchia, a drynefs which would eafily be occafioned by the contact of the air, that continually paffes through thefe cavities. It is alfo believed, that it defends the membrane of thefe very fenfible paffages againft the action of different acrid fubftances and irritating powders, fo often differminated in the air which inceffantly traverfes them; finally, the ufe is attributed to it of rendering the voice foft, and preventing the roughnefs and hardnefs which the founds iffuing from the lungs would have, if thefe tubes were dry and deftitute of this lubricating mucilage. The air which defcends very dry and very cold into the lungs, takes away much of the evaporable or aqueous part of this tracheal humour, and gives it a remarkable character of glutinofity and adhefion to the fides of the trachea; in this cafe this thickened matter, which can no longer be eafily abforbed, is difcharged by the cough which its weight and its irritation excite: fuch is the caufe and the nature of catarrhs. The glairy laminæ, or the more or lefs concrete flakes, are feparated only by a violent effort of the

the air which impels them, and then the cough is convulfive or painful; or elfe they are raifed or flowly detached from above the tracheal membrane, by this liquid humour which exudes beneath them, in which cafe they are coughed up with more facility and lefs pain. It is in this manner that confinement to the bed, by retaining the perfpirable matter in its veffels, and caufing that of the lungs to be more abundant, operates.

4. I diftinguifh by the name of *bronchial humour*, a kind of matter feparated by the glands of the fame name, which is poured into the bronchia by particular fmall excretory ducts. It is very different from the tracheal humour; it is not vifcid, ropy, nor extenfible like that matter. It is difcharged in the morning in the form of fmall, irregular, and moft frequently roundifh lumps, of a confiftence refembling a thick jelly, of a blackifh or blueifh colour, infoluble in water, at the furface of which they fwim; its quantity varies in different individuals. Though it has not yet been particularly examined, its fenfible characters are fufficient to diftinguifh it as a peculiar matter. The glands which furnifh it, and which have not yet perhaps fufficiently fixed the attention of anatomifts or phyficians, have themfelves a ftructure very diftinct from all the other glandular organs. They have been erroneoufly confounded with the fyftem of lymphatic glands. Their form, their fize, their texture, their

their colour, even their confiftence, and their difeafes, every circumftance claims the attention of fcientific men to this organ hitherto too little known. We might be induced to fuppofe, when we obferve their blueifh or blackifh grey colour, their confiftence, and that of the humour which they furnifh, that they form a kind of refervoir for the carbonous matter of the blood. Many obfervations, followed up with zeal and fagacity, are required in order to determine the ufes and the functions of this particular glandular fyftem.

5. By calling the elaftic fluid which is difcharged from the lungs by expiration *pulmonary gas*, my intention is to announce that the atmofpheric air, after having remained for fome time in the lungs, is difcharged from them in a ftate of alteration which depends upon the nature of this organ itfelf, and which I have already indicated in the hiftory of the blood. This fluid is nearly the fame in quantity as it entered, fince the carbon and the hidrogen, as well as the water ready formed, which are added to it, correfpond very nearly with the proportion of oxigen gas which it yields to the blood. It contains no more than a few hundredths of this oxigen gas; and if it has been refpired two or three times in fucceffion, which cannot be done without much difficulty, it contains none at all: accordingly, it extinguifhes inflamed bodies, and ftupefies animals. We find in it the fame proportion of azotic gas

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as before. Water is one of the materials that are added in the greateſt abundance to this expired gas, ſince nearly half a gramme of it is expired every minute, or 720 grammes in 24 hours. We alſo find in it gaſeous carbonic acid, proved by the precipitate formed by the expired air when received into ſolutions of lime, of ſtrontian and of barites; it is alſo charged with more caloric than it contained when it entered the lungs: and this is the reaſon why it depoſits water in the form of fumes when it paſſes into a cold atmoſphere. Perhaps it may alſo contain a certain portion of carbonated hidrogen; and we may attribute to this ſubſtance, which has not been rendered ſenſible in it by chemical experiments, the dangerous and deadly effects which it produces, and which are different from the aſphyxia; perhaps ſome animal miaſma, ſome contagious virus may eſcape at the ſame time with the air expired. As it has not yet been exhibited by experiment, it is only by conjecture that we may ſuſpect its influence in the production of diſeaſes, and the ſepticity which it introduces into the humours of thoſe who reſpire it. Chemiſtry ought to occupy itſelf without intermiſſion in confirming or overturning theſe ideas, and rank them amongſt thoſe phyſical truths, the proofs of which medicine muſt either confirm, or elſe arrange them in the claſs of hypotheſes; in fact, theſe are adopted in the

the theory of this important art only for want of exact experiments and facts.

6. One of the matters peculiar to the organs contained in the thorax, and which is only the product of a morbid alteration, but more frequent than has hitherto been believed or afferted, is a concretion formed in the lungs, which has been called *pulmonary ſtones*, or *calculi*: theſe are ſmall, hard, unequal and rough bodies, of an irregularly ſpherical form, reſembling ſmall pebbles, of a grey or reddiſh colour, which becomes white when they are dried in the air, and which are diſcharged by coughing, ſometimes even whilſt the perſon is in perfect health, but moſt frequently in the courſe of ſome attacks of aſthma, or of the terrible phthiſis pulmonalis. Attentive phyſicians and exact obſervers frequently meet with them in their practice. Through their care I have had a ſufficient quantity of them to be able to examine them: I have found them to be of the ſame nature with the pineal, lacrymal, and ſalivary concretions: they are compoſed of phoſphate of lime, and of a ſmall quantity of gelatinous matter. It is not known whether they proceed from the texture of the lungs or bronchia itſelf, when the patients diſcharge them; but diſſections prove that they are formed in the areolæ even of the parenchyma of the lungs, ſince in cutting the lungs a great quantity of them are ſometimes found, which grate under the ſcalpel. Here, as in many

cafes already menti oned, this phofphate of lime depofited by its fuperabundance proceeds from the white humours, when the concretion is fmall and infulated: but it may proceed alfo from the blood, efpecially, when, being numerous and diffeminated in the interior of the organs of refpiration, thefe concretions appear to occupy at the fame time the whole texture of the lungs.

Article XIX.

Of Milk and its different, economical, chemical, alimentary, and medicinal Properties.

Section I.

Natural History, or Formation of Milk.

1. MILK, a liquid fo well known, fo ufeful, fo generally employed as food and condiment, is one of the fubftances which have been moft examined by chemifts, as it is one upon which the proceffes of the arts have been extremely varied. Its hiftory muft be one of the moft detailed, as it is one of the moft important matters with which chemiftry can be occupied: accordingly, we fhall divide this article into eight paragraphs, in order to difpofe in a methodical order, adapted for facilitating its ftudy, the facts which will lead us to under-

understand its properties. The first paragraph will contain an account of its formation; the second, that of its chemical properties; the third, the chemical examination of the entire milk, such as nature presents it when it issues out of its reservoirs; in the fourth I shall treat of the whey; in the fifth of the caseous part, or cheese; in the sixth of the butter or its oily matter; the seventh will be assigned to the examination of the principal differences which this liquid presents in the species of animals which furnish it; finally, the eighth will contain the enumeration of the various uses for which different kinds of milk are employed in rude or civilized society. As milk is one of the liquids with which Nature has supplied the first wants of men, it is not to be wondered at that an immense number of observations have been collected respecting its properties, and that its history, when we consider it successively as naturalists, as physicians, as chemists, or as economists, presents very extensive details.

2. This liquid is formed in a particular organ which occupies the anterior part of the chest, in women, and a large part of the abdomen in the female animals. As there are only a small number of species of animals in which this formation takes place, and as these animals are distinguished from all others by the two well marked characters of bringing forth their young living, and of being provided with *mammæ*, they have been called *mammalia*: these are,

under

under other anatomical relations, viviparous quadrupeds and cetacea. The very beautiful form, the diſtinct protuberance, the hemiſpherical and prominent ſurface, the delicate ſkin which the breaſts of women exhibit, and which conſtitute one of the charms of beauty, the amenity and contour of which artiſts repreſent with ſuch graces, are attributes peculiar to the human ſpecies. We do not find them in the females of any other animals: the number of two is alſo given to but very few ſpecies of theſe. In moſt, the number of mammæ amounts to between four and ten. The female elephant, the mare, the gazelle, and in general thoſe animals that have only one or two young have alſo only one or two mammæ, but ſhaped very differently from thoſe of woman. The nipple is ſingle in each mammæ in woman; it is quadruple in the cow.

3. In works of phyſiology and medicine, examples are frequently quoted of milk ready formed, ſwelling the mammæ of ſome male children and animals, and even of ſome adults: the preſence of this liquid in young girls before the age of puberty is ſtill more frequently ſpoken of. Hence it is concluded that there is no neceſſary dependance between this formation of milk and the act of generation; but theſe rare facts, contrary to the accuſtomed order of nature, do not prove the opinion which is attempted to be eſtabliſhed upon this point: for no accurate experiment has proved that this was real milk:

milk: and as for its having a ſweet or inſipid taſte, an humour formed in ſome circumſtances and by ſome cauſes independent of pregnancy, is not real milk. This rare phenomenon has never been deſcribed except in man, and it has not been obſerved in the animals whoſe paſſions and manner of living are not, like ours, contrary to nature, nor force her to deviate from her ordinary courſe.

4. Under the ſkin of the mammæ are maſſes of ſolid and granulated fat, which it covers; and in a cellular texture with large meſhes is incloſed a conglomerate glandular apparatus, covered with a hard and white integument that occupies the middle of this prominent organ. This apparatus is formed of parcels ſeparated by membranous cells, and theſe parcels are themſelves formed of hard, ſolid, entire grains without cavities, compoſed of implicated veſſels. This mammary gland exiſts in males and in infants, but much ſmaller, and not ſurrounded with fat as in females: fifteen or twenty excretory ducts, viſible, elongated, hard, of a diameter ſufficiently conſiderable during the period of lactation, are collected below the areola of the breaſt, and proceed, without confounding themſelves or an aſtomoſing with each other into the nipples, where they open externally; they are inflected into the rugoſities of the papilla or nipple, and elongated or diſtended when the nipple itſelf is elongated by the

kind

kind of erection which friction or suction produces in it. A multitude of other thin and long ducts are obferved, which open into the adipofe texture, which do not belong to the glands, properly fo called, and which Haller imagined to pour a fatty humour into the milk.

5. When the uterus has conceived, the mammæ gradually grow larger, their glandular texture tumefies, the orgafm pervades it, the difpofition to form milk gradually eftablifhes itfelf, which is announced by a limpid or turbid ferofity difcharged by the papilla. After the birth of the infant, the womb having contracted itfelf again three or four days after delivery, the milk begins to be really formed; the mammæ become diftended, fwelled, and painful, and the milk difcharges itfelf fpontaneoufly. The fuction of the infant greatly accelerates its difcharge, and augments its production. There firft runs out a very liquid flightly and opaque liquid, which is the coloftrum; foon afterwards, this liquid becomes daily thicker, more perfect, white, odorous, favoury, and fufceptible of affording a more and more fubftantial nourifhment to the fuckling. It continues to flow for whole years, when the fuction and the irritation are not interrupted, and the quantity which is formed is fometimes fo abundant that a nurfe can fuckle feveral infants at the fame time.

6. The

6. The formation and, as it is called, the rising of the milk has great relation with the functions of the uterus. It seems at first that a really milky liquid is formed in this viscus; and the lochia, which have in part the same character, flow till the period when the milk is abundantly secreted in the breasts. Physicians believe that this liquid actually passes from the uterus into the breasts, and a great number of facts proves this sympathy between these two organs. They both assume their peculiar activity at the same period: the breasts become prominent as soon as the menstrual discharge appears, or the genital parts develop themselves; the milk begins to be separated when the menstrual discharge disappears in consequence of pregnancy; its suppression causes the mammary glands to become humid: these glands collapse when the menstrual discharge ceases; and these two organs, the womb and the breast, become inactive, and are excited into activity at the same periods. Physicians even avail themselves of this action when, in order to diminish the too great abundance of the menstrual evacuation, they apply a cupping glass to the breast. Discharges by one or the other way succeed, and correspond with each other. This relation is also proved by the sensation which the titillation of the nipples excites in the genital parts; accordingly the ancients admitted the concurrence of the uterus in the formation of milk.

7. Some

7. Some anatomifts admit the blood only as the fource of the milk; they believe the mammary arteries to be its fole origin. The fmalnefs of thefe fanguineous ducts has induced others to think that the arteries do not furnifh the only matter of the milk. Haller admitted in it the admixture or the addition of fat by the ducts of which I have fpoken. It is pretty generally believed that the chyle contributes more abundantly than the blood to the formation of the milk, becaufe its quantity is always proportionate to that of the nourifhment; becaufe the chyliferous veffels exhibit to the anatomift a liquid analogous to milk; becaufe milk has frequently the fmell and feveral of the characters of the aliments; and laftly, becaufe nurfes feel the milk flow into their breafts at the moment when the chyle afcends into its veffels. For thefe reafons phyficians have believed that thefe two liquids are fimilar to each other, and have defcribed the properties and the morbid affections of the different elements of the chyle like thofe of the milk: but this analogy, when carried too far, may be erroneous, and experience has not yet proved it in a direct manner. I am much more inclined to believe that the intire lymph, the quantity of which is augmented, and its motion accelerated by the chyle at the moment when it afcends from the inteftines into its ducts, contributes to the production of the milk, and that while the blood furnifhes the albumino-cafeous part, the fat affords

fords the butyraceous, and the lymph the ferous.

8. When the milk is well formed, and diftends its refervoirs, frequently the lactiferous or galactophorous tubes, being opened and dilated, difcharge it fpontaneoufly: a kind of orgafm pervades thefe tubes, erects them, dilates them, afterwards contracts them, and gives them that motion, that action which frequently caufes the milk to iffue out in more or lefs rapid jets. That fuction, or the art or mode of which nature has given to the infant from the neceffity of nourifhing himfelf with it, fingularly favours its difcharge. The vacuum formed round the nipple, with the aid of a fucking inftrument, or by means of the neck of a heated bottle applied to it, and the preffure of the air which applies itfelf with advantage to the hemifphere of the mammæ, folicits this difcharge with fuch energy, that we fee it fpout out in white streams, of which frequently fix or eight are very evidently perceived in the females of animals; the action of preffing the udder from above downwards as far as the extremity of the teat, in milking, or the art of milking, caufes the milk to flow with facility and celerity. The animals that have had their young taken from them readily fubmit to this extraction, which is attended with a pleafurable fenfation to them. Nature has connected with this excretion a pleafurable fenfation which doubles that of being a mother,

ther, and which attaches, by the gentle bond of gratitude and tendernefs, the infant who acknowledges no other mother than her by whom he is nourifhed.

9. The influence which the aliments have upon the formation of the milk, likewife merits all the attention of the phyfician. It is known that well-fed animals afford milk of good quality in abundançe. Nurfes diftinguifh foods by the property which they poffefs of increafing or diminifhing the proportion of this liquid. The acrid fmell of garlic, of the alliaceous and of the cruciferous vegetables, paffes into the milk; the perfume of flowers, the aromatic odour of faffron and of thyme, the fugar of the roots and fruits, the nectar of the petals, give it an agreeable aromatic fmell and a pleafant tafte. The red juice of the opuntia, the reddifh juice of madder, the blue of indigo, vary the colour of this nutritive liquid with the animals into whofe food thefe colouring matters have been introduced; the bitternefs of wormwood, the acrimony of the milk-thiftle, the aftriction of the aftringent plants, the purgative property of the Gratiola, are recognized in the milk; different medicinal properties are given to it, according to the different kinds of nourifhment which are prefented to animals. The milk of a nurfe who has taken a purgative, produces gripes and evacutions in her fuckling. Wine, beer, the different vinous liquors, give it a diftinguifhable property;

property; even poiſons, and ſeveral diſeaſes, are tranſmitted in this way; and the milk participates of whatever has been introduced into the ſtomach of the woman who affords it.

10. Even the paſſions with which a nurſe is agitated, modify both the abundance and the properties of the milk that is ſecreted in her breaſts; anger has been known to derange the ſyſtem of the infant, and to give it convulſive motions. Chagrin, ill humour, bad news, fear, depreſſion of the ſpirits, vitiate the ſources of the milk, and ſometimes produce a ſudden collapſion of the breaſts. Bad treatment to nurſes, manifeſtly alters their milk: accordingly great care is taken of the female animals deſtined to furniſh milk for the table, not only in the cleanlineſs and nature of their food, but alſo by kindneſs, careſſes and attentions of every kind. Several phyſicians have even carried this influence of the paſſions upon the milk ſo far, that they have pretended the milk itſelf influenced the character and the paſſions of the young individuals that are nouriſhed by it: thus it has been pretended that infants who have been ſuckled by choleric and paſſionate, mild and benevolent, lively and ſalacious, or ſtupid and phlegmatic women, acquire the ſame moral diſpoſitions. But there is reaſon to believe that this opinion is carried too far, that it is rather from the example of the effects of theſe different paſſions that the infants gradually model themſelves, and that they are only

imitators

imitators of their motions inftead of being phyfically changed in their fenforium.

SECTION II.

Of the Phyfical Properties of Milk.

11. THE quantity of the milk is varied in woman and in the animals by a multitude of circumftances. Abundance of drink in general, induces an abundance of the mammary liquid; foft, highly nourifhing and eafily digeftible aliments produce the fame effect. The farinaceous aliments boiled in water, when the ftomach digefts them well, increafe its quantity, and nurfes are well acquainted with this kind of influence. It is difficult to fix the limits, or indicate the average terms of this production: it appears however in general that the milk moft frequently conftitutes a third or a very little more of the weight of the aliments. There have been nurfes however, who, befides the milk which they afforded in abundance to their infants, yielded ftill fpontaneoufly from one to nearly two kilogrammes of this liquid in the day; in the female animals with which this quantity is much more confiderable, it is fufficiently known to vary according to the feafons, the places which they inhabit, the pafturages in which they are placed, the nature of

of the fodder which is given them in their ſtalls, their age, and the time more or leſs remote from the period when they have brought forth young.

12. The ſpecific gravity of milk is in general more conſiderable than that of water; Haller ſays that it is to the latter as 277 to 261, or 1043, 1000. It varies, according to him, and the different authors whoſe obſervations he has collected in the following proportions, 1026, 1029, 1035, 1000.

Citizen Briſſon, in his treatiſe upon the ſpecific gravity of bodies, gives the following table of that of the different milks, water being ſuppoſed 10,000.

Womans' milk	-	-	10,203
Cows' milk	-	-	10,324
Goats' milk	-	-	10,341
Mares' milk	-	-	10,346
Aſſes' milk	-	-	10,355
Ewes' milk	-	-	10,409

13. Milk is in general of an opaque white colour, which however inclines towards yellow in woman, towards blue in the cow, and varies in the ſame female according to the proportion of its principles, and conſequently, according to a multitude of circumſtances. However its opacity and its whiteneſs are conſtant, on which account it has been compared to an emulſion, and the latter has been called *milk* of almonds.

Its

Its consistence is that of an oily and aqueous liquid at the same time; when it is very strong and very good, it is a little thick, a drop remains upon the nail without running down, and extends itself upon it slowly: it is in this manner that physicians judge of the milk of nurses; a certain degree of fluidity is nevertheless preferable to a too strong consistence.

14. The taste of milk is bland, agreeable and in general almost saccharine; it has however many modifications in the different species of animals; it has something unctuous and fatty which distinguishes it, which manifestly depends upon its oily nature. Milk has a particular smell, which is pretty generally agreeable; this is one of the properties in which it is most susceptible of variation, according to the nourishment. That which is peculiar to it is however inherent in its intimate nature, and independent of the perfume or the bad smell proceeding from the aliments; it subsists only as long as it is warm; it is most perceptible at the moment when it has been discharged from the mammæ; it is scarcely to be perceived at all when it has entirely cooled; it is renewed by exposure to heat; it is dissipated by ebulition. It is very perceptible and recognizable in clean dairies, at the moment when the warm new milk is deposited in them. The milks of different animals have a particular and well-marked character in their odour.

15. According

15. According to the obfervations of Citizens Deyeux and Parmentier, the milk furnifhed by a cow at different periods, in the fpace of twenty-four hours, prefents great differences, efpecially if the milkings are multiplied at irregular diftances of time. The changes of the atmofphere, for the animals fed by pafture, are the principal caufes of thefe differences. The moft fingular remark which they have made relates to the diverfity of the milk of a fingle milking, according to the manner in which this milking is divided, and the udder evacuated at different times. The product of one milking performed with care and received fucceffively into four veffels, affords really four fpecies of milk: the firft is the moft ferous: the fecond product is lefs fo; the third ftill lefs, and the fourth contains a very large quantity of cream. The dairy women have long been acquainted with this phenomenon, and they avail themfelves of it, by keeping apart the laft product of the milking, in order to fell it, under the name of cream, to thofe who prefer the fweet, unctuous, thick and fat milk which goes by this name.

16. The times at which the milk is examined prefent variations according to the different lengths of time that have elapfed fince parturition and the firft formation of the milk. The moft ftriking of thefe differences obferved in the milk is that which characterizes it in what is called the *coloftrum*, which is firft formed immediately after parturition. The coloftrum

 is

is a fluid of a deep yellow colour, thick, viſcid and ropy, frequently carrying with it ſtreaks of blood, affording much yellow cream; and this a fourth more than the real cream of a deep yellow very ſolid butter, with a liquid leſs white and opaque than the ordinary milk, not coagulable, like the latter, by means of rennet, but viſcid and ropy, little ſaccharine. The coloſtrum changes much; from the ſecond day it loſes ſomewhat of its yellow colour and of the abundance of its cream. In four days, it paſſes into the ſtate of ordinary milk, and it is not till this period that the milk-women begin to vend it in our towns. Reckoning from this fifth day, the milk of the cow becomes conſtantly more and more perfect, acquires a better conſiſtence till the third month when it is the moſt perfect.

Section III.

Chemical Examination of the entire Milk.

17. I HAVE already obſerved that the milk has been the object of much labour and reſearch. Boyle has made it one of the ſubjects of his experiments. Boerhaave firſt treated in a ſufficiently detailed manner. Hoffman alſo made

[illegible] ents. Macquer

[illegible] and preciſion

[illegible] he was ac-

quainted

quainted with its principal properties. Spelman occupied himſelf with its fermentiſcible property; Rouelle the younger with the mucoſo-faccharine matter and the ſalts which it contains. Scheele diſcovered the ſachlactric acid, and ſhowed that the milk afforded in ſome caſes acetous acid, and that the ſpecies of acid into which it is ſpontaneouſly converted has particular and characteriſtic properties. I have given, in 1790, ſeveral new obſervations on the different materials of milk. Finally, Citizen Deyeux and Parmentier have made a great number of reſearches upon the milk of the cow, taken under many different circumſtances, upon the economical properties of this animal liquor and of its products, and upon the changes or modifications of which it is ſuſceptible. Their very extenſive enquiry concerning all theſe objects conſtitutes at preſent an entire work, which preſents the moſt complete hiſtory of this animal liquor. I have here mentioned only ſome outlines of this chemical notice and ſome of the principal authors of its analyſis. We might alſo add the numerous facts deſcribed by Verheyen, Barchuſen, Verduc, Doorſchodt, Egeling, Young, Gouraigne, Acoramboin, Geymuller, Cartheuſer and Gmelin, who have either in phyſiological works or in monographic treatiſes, given more or leſs valuable details concerning the milk of different animals. Haller has laboriouſly collected from theſe numerous writers the facts which he has

employed for his hiſtory of milk; and as the mode of proceeding of theſe authors was not uniform, thoſe multiplied quotations are more capable of embarraſſing than enlightening the reader.

18. Milk expoſed to a moderate fire dilates and ſwells conſiderably: this property is known in the domeſtic uſes of milk; it has been obſerved that it boils at the 199th. degree of Fahrenheit, that alcohol boils at 181, and water only at 212 of the ſame thermometer. There is formed at its ſurface a pellicle which gradually thickens, wrinkles, dries and grows yellow in drying. This is caſeous matter which ſeparates and becomes ſolid; when it is removed, and when we continue to evaporate the milk, there is formed a ſecond pellicle, and ſo on ſucceſſively. It is obſerved that theſe pellicles are thinner and more tranſparent in proportion as the evaporation advances; they ſeparate in this manner till there remains only a ſerous and almoſt tranſparent liquid in the veſſel. In order to obtain and perfectly ſeparate the laſt portions of the caſeous matter in this ſtate of pellicles, we muſt take care to add, towards the end, water diſtilled from the milk; when this liquid affords no more pellicles, it is no longer ſuſceptible of coagulation.

When we evaporate the entire milk to a thick conſiſtence, we obſerve that it undergoes a real coagulation, and that maſſes are formed in it; its ſolid matter, when once thickened, aſſumes a yel-

yellowiſh colour however little we may heat it more; before it acquires this colour, and when it is ſtill ſoft, though thicker and more ſolid than honey, it conſtitutes *franchipane*, a kind of ſweetmeat which is prepared by adding to the milk pounded almonds, ſugar, and orange-flowers, towards the end of its evaporation. Formerly the extract of milk was kept for preparing the whey of Hoffman by adding hot water to it. This is almoſt always a bad medicine, becauſe the extract very eaſily ſpoils, and becomes acrid and rancid.

19. When milk is heated in cloſe veſſels, and when it is evaporated on the water-bath, a large quantity of water, very little odorous and inſipid, is obtained, which preſents no phenomena by the re-agents, but which however carries along with it ſome matters in vapour, ſince it putrefies, depoſits light flakes, and becomes fetid when it is kept. This diſtilled water was formerly prepared in the laboratories of pharmacy, and great virtues were attributed to it which have at laſt been diſcovered not to exiſt. The milk is thickened and coagulated after having furniſhed this aqueous product which conſtitutes nearly two thirds of its weight, when the operation is carried ſo far as to obtain the reſiduum in the form of extract. When the extract itſelf is diſtilled by the retort it affords a turbid, reddiſh, fetid water, charged with zoonic acid and ammonia, a pretty abundant quantity of fluid oil of a

brown colour, a portion of concrete and empyreumatic oil, of folid and cryftalline carbonate of ammonia, of carbonated hidrogen gas and carbonic acid gas. The coal which remains after this operation is confiderably voluminous; by incineration it leaves in its afhes fome traces of muriate of foda, of muriate of pot-afh much more abundant than the firft and of phofphate of lime. Rouelle, who found in milk the prefence of pot-afh in the ftate of muriate, has remarked that this kind of alkali does not exift in the blood, but contains only foda, either pure or combined with muriatic acid. This may ferve to prove that another matter befides the blood contributes to the fecretion of the milk; and if it affords reafon to believe that it is the chyle as proceeding immediately from vegetable aliments—for it is the milk of the cow of which we fpeak, it announces at the fame time that the falts of pot-afh change in paffing into the blood. Both thefe confiderations prefent chemical problems the folution of which is of great importance.

20. Milk expofed to the air quickly becomes covered with a layer of light matter, of a duller white than the entire milk, which itfelf at the fame time becomes more limpid, and affumes a blueifh tinge. This white layer, which is of a bland unctuous tafte, conftitutes the cream; it feparates more or lefs quickly, according to a multitude of circumftances, and in a quantity which, in the milk of the cow, always correfponds

ponds with the goodneſs and abundance of the nouriſhment; hence the poetical expreſſion of fat paſturage. It is more yellow and conſiſtent, the more this nouriſhment is abundant and of good quality. The cream contains the butyraceous oil, which is not yet butter ready formed, with a ſmall quantity of very light and very bland caſeous flakes, and a conſiderable proportion of whey or ſerum. Though the cream alone furniſhes the butter, it never ſeparates ſpontaneouſly and without agitation; it is known that it may be converted into light and fat cheeſes. Cream is one of the products of milk upon which the quantity and quality of the nouriſhment given by the aliments has the moſt influence. It is ſingularly changed, diminiſhed in quantity, and aſſumes a diſagreeable ſmell in diſeaſes, as is conſtantly obſerved in the epidemic diſeaſes of animals. I have obſerved that the contact of the air contributes much to the ſeparation and the butyrization of cream. It is obtained more ſpeedily in flat and wide veſſels, which preſent a large ſurface to the atmoſphere, than in narrow veſſels. I ſhall revert to this phenomenon in the hiſtory of butter.

21. The entire milk, the intoxicating property of which ſome travellers have announced, eſpecially the mare's milk in Siberia, and that of the ewe in the Hebrides, is ſuſceptible of paſſing into the vinous fermentation. This art has long been practiſed by the Tartars

Tartars and the Nomadic nations. They leave the mare's milk in large buckets, and even mix it with blood, and they obtain from this mixture an intoxicating liquor which they uſe inſtead of wine. It has been found, in performing this experiment with care, that the vinous fermentation of the milk does not take place unleſs when it is in conſiderable maſſes; that the integrity of all its elements was requiſite to the effect; that it did not eſtabliſh itſelf well except in milk of good quality and above ten degrees of temperature; that a ſlight and repeated agitation of this liquid in cloſe veſſels accelerated and favoured it, by mixing well all its materials which tended to ſeparate from each other; that there was diſengaged a conſiderable abundance of elaſtic vapour, to which it was neceſſary to give vent from time to time, and that this was carbonic acid; that there was formed a viſcid and tenacious ſcum, a ſort of coating at its ſurface; finally, that the milk, whilſt it underwent this inteſtine and vinous motion became in part acidified and coagulated. When theſe phenomena have taken place, the milk, which is clotted, of a pungent ſmell, acidulous and vinous at the ſame time, being ſubjected to diſtillation, by a ſlight ebullition, affords a product of alcohol in little abundance, and acid at laſt, which may be rectified by two ſucceſſive diſtillations, and preſents all the properties of this liquid, which is identical in all caſes,

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as it always proceeds from one common ſource: but its quantity is always ſo ſmall that it can never be extracted from milk with advantage. It will appear that the ſlightly ſaccharine matter contained in this liquor is the true origin of this alcohol, and the cauſe of the vinous fermentation of which it is ſuſceptible.

22. If the temperature of the air exceed fifteen degrees; if the milk be expoſed to the air; if it be agitated in order to retard the ſeparation of the cream and to keep the materials well mixed together, it paſſes into another kind of fermentation, and acquires an acidity ſenſible both to the ſmell and the taſte. Every one knows that milk turns ſpontaneouſly ſour when it is kept for ſome time; that great changes of the atmoſphere, eſpecially electric commotions and tempeſts contribute greatly to this aceſcence: that it is retarded by boiling it, which is attributed to the diſengagement of its odorous matter, though it has perhaps no influence upon this property: at the ſame time that it undergoes this change the milk curdles or coagulates; its conſtituent materials ſeparate; ſolid clots more or leſs voluminous are precipitated from it; frequently even this ſeparation of ſolid matter takes place in a ſingle piece, and we ſee a white opaque, ſemi-concrete maſs, ſhrunk together, and ſurrounded with a yellowiſh liquid a little turbid, which gradually augments, and ſeparates from the ſolid maſs in proportion as the particles of the latter approach and condenſe. The

The portion of the milk thus ſpontaneouſly thickened and coagulated is called the curd, and the liquid is denominated the whey. The latter has a ſour taſte and a pungent odour; it is in proportion and at the moment when it has acquired this taſte that the caſeous matter becomes ſolid and ſeparate. In this manner a new acid is formed, which ſhall ſoon be examined by the name of *lactic acid.* In the ſpontaneous decompoſition of the milk, and in its ſeparation into ſolid and liquid matter, we find a remarkable analogy with what happens to the blood; but here it is the product of an acidification which does not take place in the vital liquid, and the compariſon if carried too far becomes a real error.

23. Though it be well proved that milk is ſuſceptible of forming by fermentation an acid of a particular nature, it is however not leſs capable of aſſuming by a ſlight modification the character of true acetous acid. Scheele has found that by mixing ſix ſpoonfuls of alcohol with about three litres of milk; ſuffering this mixture to ferment in a well-corked bottle, and taking care to give vent from time to time to the elaſtic fluid diſengaged during this fermentation, the milk was converted at the end of a month into very good vinegar. It is only requiſite to paſs it through a piece of linen in order to ſeparate the coagulated caſeous part, and then to keep it in well cloſed veſſels: it may be employed, like real vinegar for economical and domeſtic uſes.

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We ſee in this property the conſequence of the vinous fermentation and the rapid paſſage of milk into the ſtate which commonly follows wine, when we begin by adding to it a portion of the eſſential product of this fermentation: thus is eſtabliſhed a very remarkable analogy of nature between the lactic acid and the acetous acid.

24. Milk is coagulated and decompoſed by all the acids, the ſtrongeſt as well as the weakeſt. Of all the animal liquors it is that which preſents the moſt prompt and eaſy coagulation. A large quantity of curds more or leſs voluminous is formed and ſeparated from it at the very moment when an acid is poured into it; when it is concentrated and agitated a little, it produces a ſolid curd which however divides into flakes by further agitation. Every one knows the uſe of the weak acids in effecting the coagulation of milk. The curd thus formed and well drained retains no acid taſte, and the acid that has been employed remains entire in the ſupernatant liquor. It is therefore by uniting with the ſerum that the acids ſeparate the caſeous portion, and it is to its tendency to become concrete that the coagulation of this matter is to be aſcribed. This we ſee eſpecially in the curd ſpontaneouſly formed, which retains none of the acidity of lactic acid when it has been drained, preſſed and waſhed. We ſhall hereafter ſee that this effect is produced by the attraction of the acid in general for the water of the milk, by the little ſolubility of the infu-

insulated caseous matter, and by the little attraction of the acid for this matter.

25. The alkalies do not produce the same effect of coagulation upon milk, though they first separate the cheese from the water, and thicken this fluid at first, because they have a very strong attraction for the caseous substance. Their action upon milk has even been opposed to that of the acids, because when an alkali is added to this liquid once coagulated, the coagulum is actually re-dissolved, by strong agitation. Ammonia especially enjoys this property; it dissolves the curds formed in milk by the acids very quickly and easily: it re-establishes in some measure milk that has been turned in some hot drinks; and it is employed for fusing the milk and causing it to flow in the breasts of lying in women, when they are attacked with that very painful disease the trichiasis. Boerhaave having observed that the *oil of tartar*, or a condensed solution of pot-ash proceeding from burnt tartar, being boiled with milk, gave it a yellow colour which passed into the red, thought that this phenomenon resembled the blood, and that this liquid proceeded from a similar combination between the chyle and the alkaline humours. This effect of colouration, which never goes so far as redness, and is very different from the phenomenon of sanguification, depends upon the re-action of the alkali upon the caseous matter of the milk and upon the transition

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of this matter into the ſtate of a kind of carbonated oil, as I ſhall ſhow hereafter.

26. The ſalts, of whatever nature they may be, have conſiderable action upon the component materials of milk, in ſeparating them from each other, and it is in this manner that they decompoſe and coagulate this liquor. It can only be by their attraction for the water that they produce this effect; and we ſee that the greater this attraction is, the more ſpeedily they effect the coagulation of the milky liquid. Scheele well underſtood the cauſe and the preſence of this phenomenon.

The metallic ſalts and ſolutions act in a complicated manner upon milk, on account of the multiplied attractions exerted by the ſaline matters diſſolved in this liquid; but we muſt here confine ourſelves to the enunciation of their coagulating and decompoſing action in general, conſiſting in the ſeparation of the caſeous matter. Other details of their effects belong to the particular properties of the inſulated materials of milk, and we ſhall treat of them in the ſubſequent paragraphs.

27. It is known by all the economical uſes of milk, that this liquor unites eaſily with ſeveral vegetable matters; that combines with gum, ſugar, the amylaceous fecula, the aromatics and ſeveral colouring matters; that ſome give it a more or leſs thick conſiſtence, and agreeable taſte, a pleaſant perfume, and varied colours. But chemiſtry ſhows that theſe combinations are

are merely tranſient, that they take place only at the expenſe of the nature itſelf, and of the intimate mixture which conſtitute this liquid, ſo that it is more diſpoſed to be altered and decompoſed. Scheele has proved that all theſe matters, diſſolved in the milk and eſpecially if heated with it, effect its coagulation and the ſeparation of the cheeſe. He has conſtantly attributed this effect to the ſolution of theſe matters in the water, and to the ſuperiority of their attraction for this liquid over that which the caſeous ſubſtances has. Many flowers, grains, leaves and parts of vegetables in general exert the ſame decompoſing and coagulating action upon milk, though the plant which has received the French appellation of Caille-lait (*gallium*) poſſeſſes this properly in an inferior degree ſo many others, as Citizens Deyeux and Parmentier have found. Many of theſe vegetable ſubſtances are employed, as we ſhall ſee, for inſulating the caſeous from the ſerous part. We find the ſame effect in ſeveral animal ſubſtances, both mucous and gelatinous, ſuch as the membranes of the ſtomach of man, of birds, &c. fiſh-glue, the ſkins of all animals, whether acidulous or ſuſceptible of aceſcency, as runnet, and animal jelly, and they are employed for the ſame uſes. Alcohol alſo decompoſes milk, and coagulates it into very ſmall flakes, which may be immediately rediſſolved in water. This ſeparation of the flakes of cheeſe and butter proceeds, like that

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of a diffolved falt from the attraction which alcohol has for water.

28. All thefe chemical phenomena of the entire milk prove that this liquid is a very compound fubftance, the materials of which are but feebly united with each other. It prefents itfelf as a momentary combination, a kind of fufpenfion of fat and oily matter in a mucous and faline liquid, the adhefion of which is but weak, the equilibrium little permanent, and the principles of which tend to feparate by a multitude of caufes. On this account milk has been confidered as a kind of animal emulfion, and compared to that which is obtained by the trituration of oily and mucilaginous feeds in water, to the thick liquid which is prepared by triturating gum and oil with this fluid; but in order to know whether this comparifon affords an exact notion of the nature and compofition of milk, the properties of each of its component materials muft be examined; namely, the ferum, the cafeous part and the butter.

Section IV.

Of the Serum of Milk, or of Whey.

29. THE ferum of milk, or whey, is the moft abundant part of this liquid. We do not here treat of what is called *whey* in the dairies, or of the liquor feparated by acefcence; it is of the ferum not turned four that I intend to fpeak, and particular proceffes are requifite for extracting it or feparating it from the milk: the following is that which is generally employed with fuccefs. The entire milk is heated, runnet being added to it in the proportion of about a gramme to the litre: this fubftance, proceeding from the refidue of the milk coagulated in the ftomach of the calf and the gaftric juice which is mixed with it, caufes the milk to coagulate with facility. It is then fuffered to boil for fome moments, after which it is paffed through a ftraining cloth: there runs off a liquid ftill turbid, which is to be clarified with white of egg and agitated in a little water; when it has cooled it is filtrated through a double paper without fize. We may employ the membrane of the ftomach of birds, or the flower of the thiftle, or of the artichoke for coagulating milk. When we employ the tartarous acidule in fine powder, or vinegar, the whey which we obtain

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is not pure, but prefents properties that do not belong to that fluid.

30. The whey or the ferum of milk thus prepared is a liquid perfectly limpid, of a greenifh-yellow colour, of a light faint and fweetifh fmell when hot, inodorous when cold, of a fweetifh, flightly faccharine and unctuous tafte. Its fpecific gravity is a little lefs than that of the entire milk; Mufchenbroeck had eftimated it at 1016, the milk from which it proceeded being 1030; Citizen Briffon gives for the fpecific gravity of the milk of the cow 10,324, and for that of the clarified whey which was extracted from it, 10,193. Previous to its clarification it ftill contains a fmall quantity of cafeous matter, which impairs its tranfparency and is fufpended in it in flakes. By a mild heat continued for fome time, it clears and depofits thefe flakes. It is alfo, in this ftate, turbid, and of a greater denfity than after its clarification. The denfity of this purified liquor proves that it is very different from water, which is alfo confirmed by its colour and tafte: accordingly, whey is a very nourifhing liquor. Befides thofe patients who are fupported and fometimes even too highly nourifhed with this animal liquor, the hiftory of the arts prefents two remarkable facts refpecting this property, which relate to two celebrated men. Boerhaave lived feveral fucceffive months without any other nourifhment than whey, and Fergufon made it his nourifhment during eighteen whole years, adding

adding to it only a ſimple decoction of barley.

31. The action of heat upon whey affords reſults different from thoſe which milk preſents. When evaporated in open veſſels, or diſtilled on the water-bath, there is ſeparated from it a large quantity of ſlightly odorous water, which contains nothing ſenſible to the re-agents, though it becomes altered by putrefaction; the whey becomes coloured, grows brown, turbid, thick, becomes viſcous and concrete like granulated honey: if in this ſtate it be heated in a retort, it does not furniſh the ſame products as the entire milk; they have not the ſame fetidity; they do not contain an equal proportion of carbonate and of zoonate of ammonia; we find in them on the contrary pyromucous acid and ammoniacal pyromucite; the gas is leſs carbonated hidrogen than carbonic acid; the coal which it leaves is light and burns eaſily; we find in its aſhes a ſmall quantity of carbonate of pot-aſh, of muriate of ſoda, and more of the muriate of pot-aſh and phoſphate of lime.

32. When we evaporate the ſerum of milk to the conſiſtence of a ſyrup, and afterwards let it cool ſlowly, there are depoſited from it irregular cryſtals of a brown yellow colour, of a fat and unctuous appearance, which, when re-diſſolved in water and purified by two ſucceſſive operations, paſs through the yellow tinge and at laſt arrive at the ſtate of white cryſtals in regular paralelopipeds. This matter

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is what is called the ſalt or the ſugar of milk; a ſubſtance very remarkable in its properties, and which deſerves to be ſtudied with attention.

Kaempfer aſſures us that the Brachmans have long known the art of extracting the ſugar of milk. Fabr. Barthollet or Bartholdi, an Italian phyſician, was the firſt who made expreſs mention of it, in 1619. Etmuller, Guterman, Teſti, Werloſchnigg, Wallerius, Fickius, Cartheuſer, Vulgamoz, and Lichtenſtein have ſucceſſively written its hiſtory and examined its properties. Rouelle the younger, Scheele, Hermſtadt, Citizens Deyeux and Parmentier have eſpecially occupied themſelves with its nature and chemical compoſition. We ſhall ſee that notwithſtanding the labours of theſe able men, there ſtill remains ſomething to be deſired reſpecting this ſingular ſubſtance, the formation and the exiſtence of which in the milk preſent conſiderations of great importance to the phyſiologiſt.

33. The ſugar of milk is prepared in conſiderable abundance in the mountains of Switzerland, a country ſo renowned for the excellence of its paſturages, and for that of the milk of its cows, as well as its different products. They take the ſerum obtained from ſkimmed milk coagulated by runnet, boil it and evaporated it freſh, before it turns ſour, till it has acquired the conſiſtence of a thick ſyrup, and becomes fixed into a granulated matter by cooling. It is then poured into earthen moulds like the boiled juice of the ſugar-cane; in which

it condenſes into a maſs which is dried in the ſun: ſometimes it is poured into veſſels with flat ſides, in which it aſſumes the form of cakes. It is very impure in this firſt operation; it is refined by diſſolving it in water and clarifying the ſolution with white of egg; it is boiled again to the conſiſtence of a thick ſyrup, which is ſuffered to cryſtallize gradually by cooling: and thus afford white cryſtals in rhomboidal paralelopipeds. The mother-water which is decanted from the cryſtals depoſits others of a yellow or brown colour which are ſucceſſively purified or refined. It is not without great difficulty that ſome rudiments of cryſtals of ſugar of milk are obtained in the ſmall way in our laboratories; but we ſeparate this body in the granulated and honey-like form. It appears, when we take the average term of the proportions which authors have indicated in the different kinds of milk, that the maximum of its quantity is one-twenty-eighth and the minimum one-ſixtieth of the milk.

34. M. Lichtenſtein has made the analytical examination of the different varieties, or rather of the different ſtates of the ſugar of milk, which are ſold at different prices in the Helvetic Republic. The following are the principal of them which he diſtinguiſhes:

A. *The white and pure ſugar of milk*, extracted from the purified ſerum.

B. *The aceſcent ſugar of milk* extracted from whey

whey that has turned ſour: it is coloured, fatty, moiſt, and impure.

C. *The ſugar of milk mixed with mother-water or fatty parts*, as the author calls them, is that which ſeparates in the firſt cryſtallization.

D. *The ſugar of milk mixed with oil and muriate of ſoda*, which cryſtallizes the laſt.

E. *The ſugar of milk mixed with fat parts, with muriate of ſoda, and with muriate of ammonia*; this is adheſive and moiſt; it affords ammonia by the fixed alkalis.

F. Finally, a variety of ſugar of milk mixed with all the ſubſtances already indicated, and alſo with an extractive part and caſeous matter. This laſt, the moſt impure of all, becomes rancid: and in this ſtate it is acrid and pernicious. In France, the different varieties of theſe ſugars of milk are not known.

35. The ſalt or ſugar of milk, when well purified and cryſtallized, preſents to the chemiſt properties which belong to no other ſubſtance. It is white, cryſtalline, of a faint taſte, and ſeemingly earthy, notwithſtanding the name which it bears, unalterable by the air: it is much leſs ſoluble than ſugar, ſince four parts of hot water are required for the ſolution of one part of it; more than twelve of cold water are requiſite. Placed upon ignited coals, it becomes brown, fuſes not ſo well nor ſo ſpeedily as ſugar, exhales white fumes, having a pungent odour of caramel, the fumes of which they reſemble, ſwells, inflames, and leaves a black

black coal, lefs light, rather eafy to be incinerated, leaving $\frac{1}{200}$ (30 grains in the pound) of the weight of the primitive falt, in which Rouelle has found a mixture of three-fourths of muriate of pot-afh, and one-fourth of carbonate of pot-afh. Diftilled in a retort, it affords water charged with pyromucous acid, fome drops only of red oil, much carbonic acid gas, mixed with carbonated hidrogen gas, and a light coal of the nature already indicated. According to its properties, Rouelle and Vulgamoz have confidered it as real fugar. Scheele has confirmed that opinion by converting this matter into oxalic acid by means of nitric acid.

36. But a particular difcovery of Scheele, relative to this fugar of milk, has however fhown that this kind of mucous body prefents a very effential difference from fugar properly fo called. In treating it with the acid of nitre, he remarks that it required more to change it into oxalic acid; that it afforded only a little more than one-eighth of its weight of this acid; and that there was gradually feparated from it a white powder, little foluble, in which he found the characters of a particular acid which he calls *acid of fugar of milk*, and which has fince been defignated in our nomenclature by the name of *fachlactic*, and of which I have given the hiftory, under that of *mucous acid*, in the article concerning gum or vegetable mucus, becaufe this fubftance has, like the fugar of milk, the property of affording it by the

the action of the nitric acid. It has been feen in this article that Mr. Hermftadt, who has inferted in Crell's Annals of Chemiftry two Memoirs upon the fugar of milk, believed that the mucous or fachlactic acid was oxalate of lime difguifed by a fatty matter; but Scheele, who had alfo fufpected the fame could not verify it, nor has it received more confirmation from our experiments. From the little tafte and folubility of the fugar of milk and its property of forming mucous acid like gum, I confider it as a fort of intermediate fubftance between the mucous fubftance and fugar; I believe it to be the product of the work of digeftion; for it is formed in the carnivorous animals, in the milk of which it is even abundant, as well as in the frugivorous, and it is difficult to believe that it paffes immediately from the ftomach into the mammæ by the chyle. Perhaps it may be this mucofo-faccharine compound which is found in the urine of perfons labouring under the *diabetes mellitus*. Citizens Deyeux and Parmentier believe that the fugar of milk, which they affert to be more foluble in milk than in water, is a combination of fugar and fachlactic acid, and that it may be formed artificially by uniting thefe two matters. I have no knowledge nor can I fay any thing concerning the experiments upon which they ground this affertion, which I muft confefs however appears to me to accord very ill with what we know of the properties

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of the two fubftances which they fuppofe to be combined.

37. When we have obtained all the fugar of milk contained in the ferum, the liquid which remains as mother-water is brown, vifcous, thick, and gluey; it affords by cooling, as Rouelle the younger remarks, an almoft tranfparent jelly, and it concretes into a tremulous mafs, like an animal decoction. It is in this mother-water alfo, that feveral faline matters exift, which may be feparated from it, if after having diluted it with a fmall quantity of water, it be evaporated very gently, and with the attentions with which experiments of this kind ought to be conducted. They are cubes of muriate of pot-afh which depofit themfelves thus in the cryftalline form: the phofphates of foda and of lime, which form part of the depofit, and which other experiments enable us to difcover in it, are too little abundant and too much difguifed by the former cryftals, to be perceptible in it. The re-agents by which they are indicated prefent particular phenomena with the entire milk previous to its evaporation or concentration; thefe are the alkaline and metallic folutions. Lime-water, the folution of ftrontian and of barites precipitate the ferum of milk very fenfibly; the precipitate is an infoluble earthy phofphate. Pot-afh, foda, and ammonia form in it a light mafs, which is only precipitated phofphate of lime. Amongft the metallic falts, the nitrates of mercury and filver

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are thofe whofe action upon the ferum of milk has been the beft examined. The firft forms in it a precipitate of a greyifh-white colour, which becomes rofe-coloured by drying in the air; the fecond, in precipitating it, remains in a white powder. Both thefe precipitates afford traces of phofphorus when they are diftilled alone or with pulverized charcoal at a fufficiently elevated temperature. They are compofed of metallic muriate and phofphate coloured and foiled by a gelatinous animal matter. The action of the acids upon whey, has nothing remarkable; the concentrated fulphuric acid colours and reduces it to coal; the nitric changes it into oxalic and fachlactic. The concentrated whey turns fyrup of violets green: Rouelle the younger attributed this colour to the yellow of the liquor.

38. We fee that by the preceding re-agents the ferum of the milk is altered only as to its faline fubftances, that they alone produce the effects announced, and that the mucofo-facharine and gelatinous fubftances, which however conftitute its principal materials, (for the falts amount in it only to fome thoufandths,) experience no change or alteration, at leaft not perceptibly by their precipitation by means of thefe re-agents. Indeed it cannot be doubted that the cauftic alkalies and the powerful metallic falts act upon thefe two organic fubftances, as is indicated by the change of the colour of the fluid, and the colouration of the

the precipitates; but these slight modifications are but little appreciable. Thus the object of the chemist, in treating whey by the re-agents, is particularly to exhibit its saline properties. There are, however, also means, without other re-agents, of separating and obtaining distinctly the mucous and gelatinous compounds, and of distinguishing them from each other, and from the saline materials that are mixed with them. When the serum of milk thickened and concentrated by fire has acquired the consistence of a thin syrup; if we throw into it a sufficient quantity of alcohol, a flakey and mucous deposit is formed which contains the sugar of milk, and the gelatin, equally insoluble in this liquid, and separated from the water by reason of the strong attraction which it has for alcohol. The serum thus thickened may be precipitated, though little abundant, by tannin which seizes only the gelatinous substance which it contains, and we may afterwards find again in it the mucoso-saccharine salt which it contains by the addition of alcohol, which precipitates it in its turn.

39. I have strongly insisted in my experiments on the analysis of the serum of milk upon the presence of the phosphate of lime, which, by its quantity, has appeared to me to follow immediately after the muriate of pot-ash. We find it in the ashes of whey when entirely evaporated and burned, or in those

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of the coal which it leaves after its diſtillation. It is this which is precipitated by the addition of pot-aſh, of ſoda, and of ammonia, in well clarified whey, and the precipitation of which becomes much more ſenſible which this humour has been previouſly concentrated by evaporation. The oxalic acid which conſtantly renders the ſerum turbid, and forms in it a precipitate of oxalate of lime, affords alſo the proof of its exiſtence by the earthy baſe which it takes from it: the phoſphates of mercury and lead which are obtained by the nitric ſolutions of theſe metals, and which contain its acid, complete the proof. The little ſolubility of this ſalt, and its exiſting nevertheleſs in the proportion of ſeveral thouſandths in milk, prove that it enters into the plan of nature to furniſh it conſtantly to the young animals in this firſt nouriſhment which they take ſo greedily and ſo abundantly. I have thought I had found the reaſon of this view of nature in the rapidity and energy of oſſification at this tender age of life.

40. One of the moſt characteriſtic properties of the ſerum of milk is that it turns ſour with great facility: perhaps it paſſes previouſly into the vinous fermentation; but this is ſo feeble and ſlight, that it is difficult to ſeize the inſtant of the tranſition. The aceſcence on the contrary is the moſt conſtant and the moſt marked phenomenon which this liquid preſents in the courſe of its ſpontaneous alterations. It is by this

this motion that the lactic acid is formed. The whey commonly becomes turbid and depofits fome light flakes of cafeous matter in proportion as it becomes four: if we add two or three fpoonfuls of alcohol to each litre of this ferum, we obtain acetous acid inftead of lactic acid, as with the entire milk. I have already remarked that Scheele in examining milk that had fpontaneoufly become four, difcovered a particular acid in it: he has given both the means of purifying it and the hiftory of its principles and combinations. No chemift has added any thing to the work of Scheele. It is proved that the formation of this acid is owing to the alteration of the fugar of milk or of its mucofo-faccharine matter; for when this acid is once well formed, when the whey having become ftrongly acid intenfely reddens the blue vegetable colours, we no longer obtain this matter from it by evaporation and cryftallization.

41. Scheele not having been able to fucceed in feparating the acid of four whey by diftillation, but having obtained by this operation only a little acetous acid, the formation of which appears conftantly to accompany that of the lactic acid, endeavoured to obtain this fixed acid by other means. The following is that which fucceeded the beft with him, and which, though complicated, proves the fagacity and extenfive refources of this able chemift. Sour whey is evaporated to an eighth of its volume by

by a very gentle fire; it is filtrated in order to ſeparate from it all the caſeous matter thus coagulated in flakes; lime water is added to precipitate the animal earth, that is to ſay, the phoſphate of lime; it is then diluted with thrice its weight of pure water, and the exceſs of lime is precipitated from it by the oxalic acid, the latter being added in no larger proportion than is neceſſary, and ſo that an addition of lime-water ſhall form in it neither cloud nor ſtreaks; the liquor is evaporated to the conſiſtence of honey, alcohol is then poured into it, which ſeparates the portion of ſugar of milk or other extraneous matter, and diſſolves the lactic acid; laſtly, the liquor being drawn off clear is diſtilled till all the alcohol that has been added is collected: and what remains in the retort is pure lactic acid. The following are the ſpecific and charactereſtic properties which the Sweediſh Chemiſt has found it to poſſeſs.

42. It has a rather ſtrong ſour taſte which is not agreeable; it is in the liquid and viſcid form when concentrated; it reddens the tincture of turnſole well, and it gives a violet-red tinge to the ſyrup of violets. Evaporated even to a very denſe conſiſtence, it does not aſſume either the cryſtalline or granulated form; but it has a muciliganous viſcoſity. Diſtilled in a retort, it affords a pretty ſtrong empyreumatic acid analogous to the pyrotartarous, with very little oil, and the carbonic acid and carbonated hidrogen gaſes, and a coal in little abundance adhering to the glaſs.

glaſs. When united with the three alkalies, with barites and with lime, it forms ſalts little cryſtallizable and deliqueſcent. Its combination with magneſia cryſtallizes, but it alſo attract the moiſture of the atmoſphere: moſt of theſe earthy and alkaline lactates are ſoluble in alcohol. The lactate of ammonia is not known, neither are thoſe of alumine, of glucine and ſtrontian; what Scheele has given us relative to the properties of theſe ſalts is ſtill only a firſt notion. We find in it nevertheleſs relations with that of the acetites: however the lactic acid decompoſes the acetites.

43. The combinations of the lactic acid with the metallic oxides have alſo occupied Scheele; but he ſtudied only what appeared to him to be neceſſary for diſtinguiſhing and characterizing the lactic acid, and he had not the intention of examining their complete ſeries: ſo that his work preſents in this reſpect only a ſlight outline of what the ſcience requires. According to his enquiries, the lactic acid does not in any manner attract cobalt, biſmuth, antimony, mercury, ſilver and gold, notwithſtanding the long duration of contact between theſe bodies and even with the aid of ebullition. Zinc and iron are oxided and diſſolved in it, as in almoſt all the acids, with diſengagement of hidrogen gas: which announces that they decompoſe the water, that the lactic acid augments their attraction for the oxigen, that it favours and accelerates the decompoſition of the water, and

and that these two metals contract no adhesion with it till after they have previously been oxided. The lactate of zinc crystallizes; that of iron forms only a brown deliquescent mass. The same acid oxides and dissolves lead and copper. Frequently, during the solution of the first of these two metals, a small quantity of sulphate of lead is precipitated, which announces the presence of a small quantity of sulphuric acid in this acid.

44. We see, according to this faithful exposition of the labours of Scheele upon the acid of soured whey, how much is still wanting of facts in order to make us thoroughly acquainted with its properties: those which he has described are merely sufficient to prove that it is a particular acid different from all others. Besides the great number of its saline compounds which are still wanting to the science, Scheele has not indicated the action of fire upon this acid, its spontaneous alteration in the air, its habitudes with the nitric acid, &c.: it is not known whether it is totally decomposed by the latter or converted into another acid, especially the oxalic, as several vegetable acids are. Its intimate nature and composition are entirely unknown: though it presents properties which approximate it to the acetous acid, and which may lead us even to believe that it is very similar to it, I still find it impossible to rank it amongst the vegetable acids. On the other hand, I find it equally impossible to adopt a decided opinion relative

relative to its animal nature, ſince no experiment has hitherto exhibited the preſence of azote in it, and ſince it is unknown whether it can afford ammonia in its decompoſition, whether it is putreſcible, whether it can be converted into Pruſſic acid, as we know can be done with all the well characterized animal matters. It muſt therefore be a ſubject of reſearch for chemiſts, if they wiſh to acquire a more poſitive knowledge concerning it.

45. It may be inferred from all the facts contained in this paragraph, form all the analytical experiments upon the ſerum of milk or whey, of which I have juſt given an account, that this liquid is compoſed of a large quantity of water, of a variable proportion of mucoſo-ſaccharine cryſtallizable matter, of gelatin and of ſome ſaline matters, eſpecially muriate of pot-aſh, perhaps of ſulphate of pot-aſh and phoſphate of lime; that the two firſt ſubſtances render it ſweet, ſaccharine, ſuſceptible of fermentation, of aceſcence, of affording nouriſhment, of cryſtallizing, of concreting into a jelly, of being precipitated by tannin; that the ſalts, and eſpecially the phoſphate of lime are the cauſes of its precipitation by the alkalies, of the traces of phoſphorous which its metallic precipitates treated by an intenſe fire yield; that the knowledge of theſe conſtituent materials explains its nutritive quality and its ſpecial advantage as the firſt aliment of young animals; that this compoſition of the ſerum of milk may be regarded with reſpect to it two moſt

moſt abundant principles, the mucoſo-ſaccharine ſubſtance and the gelatin, as the natural link which contributes to hold a ſlight combination with the other materials of the milk, and eſpecially the butter; finally, theſe two matters perform in ſome meaſure the office of the gum in loches, or of the mucilages in the emulſions of vegetable ſeeds.

SECTION V.

Of the Caſeous Matter and of Cheeſe.

46. THE caſeous part of milk is obtained by means of a great number of different ſubſtances which have the property of turning or coagulating it. In order to obtain this ſubſtance pure, we muſt be careful to take ſkimmed milk, that it may not be mixed with butyraceous matter. Runnet, the flowers and the receptacles of moſt of the compoſite or ſyngineſian plants, and all the aſtringent plants, have the property of curdling or coagulating milk in the cold with the aid of a little time; the acids, whatever they may be, have the ſame property; and as they remain diſſolved in the ſerum, we may employ them, provided we uſe them weak and in ſmall quantity, for obtaining the caſeous part. We may alſo employ the dried membranes of the ſtomach and inteſtines of animals, glues, jellies,

jellies, and membranes, which produce the fame effects. We have already feen that alcohol alfo acts in the fame manner in the decompofition of milk. The cafeous fubftance is feparated, either in the form of fmall infulated flakes, or in that of a kind of tremulous matter in a fingle white and opaque piece, or in that of thick maffes which tend to condenfe and harden.

47. In dairies the milk is turned by different means, but efpecially by runnet employed cold, for preparing cheefe. Thefe are in general of two kinds accordingly as they have been prepared either with entire or pure milk, or with fkimmed milk. The firft conftitute the fat unctuous cheefes, which retain a foftnefs and opacity, which have a fine and fweet pafte, and by a flight alteration run and form a fort of thick fyrup, as we fee in the good cheefes of Brie. Skimmed milk affords a hard aud folid cafeous mafs, which becomes dry and brittle, and, when ftrongly compreffed acquires a femi-tranf-parency and conftantly preferves its folidity, growing hard inftead of foftening and run-ning. In order to fabricate and preferve them they are put to drain upon hurdles, they are falted and kept in low and moift fituations, they are fometimes inclofed in hoops of thin and flexible wood or bark, which are bended round their fides and clofed every day fo as to diminifh their diameter; they are alfo falted at their furface. By thefe proceffes the water of the cafeous matter is preffed out, its flakes are

are brought nearer together, and they are made to acquire a homogenous confiftence throughout their whole continuity.

48. There are many differences in cheefes, according to the diverfities of the milk, the nature of the runnet which is employed for feparating and precipitating them, the art of preffing, kneading, draining, drying and expofing them to different degrees of alteration or of fermentation; according to the quantity of whey which is left in them, the force of preffure which is employed, the temperature to which they are fubjected, the kind of package or piling which they undergo, the time during which they are treated in this manner; laftly, according to the general combination of all the circumftances which prefide in fome refpect over their preparation. In order to obtain cheefes with a dry, denfe, femi-corneous and femi-tranfparent pafte, like thofe of Gruyere; the cafeous matter being feparated from the coagulated milk is kneaded in the hands: after it has been properly worked, it is drained upon hurdles or compreffed and kneaded anew; the cheefes are preffed and the ferum forced out of them, not only moveable by the hoops which are brought clofer every day, but alfo with weights placed upon them after they have been piled one upon the other; when once dried they are falted at feveral times; the white and blue mould which forms upon their furface

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is repeatedly ſcraped off; this is diſcontinued when this mould formed upon the dried rind has aſſumed a red colour; the fermentation is conducted ſlowly and gently till it has communicated to the cheeſes the taſte and ſmell which ought to charaſterize them. This operation is performed in ſubterraneous buildings, or cool vaults, and at a conſtant temperature of between 2 and 5 degrees + 0. Such are the ſo famous cheeſes of Roquefort.

49. It is not upon theſe cheeſes prepared by art and more or leſs altered by a fermentation which none of them eſcapes, and which is conſtantly obſervable in all or almoſt all theſe alimentary preparations, that chemiſts make the experiments proper for aſcertaining the properties. It is to this matter in its freſh ſtate, not altered but ſtill natural, ſuch as it is precipitated from the milk at the very moment of its decompoſition, that they direct theirattention, and upon which they perform their experiments. The caſeous ſubſtance, which is not yet cheeſe, obtained in this manner and well preſſed, is in the form of white granulated flakes, eaſily ſeparable from each other, ſuſceptible however of being cruſhed under the finger like a ſort of paſte, of a ſweetiſh taſte which is not diſagreeable. It powerfully retains the laſt portion of ſerum lodged between its interſtices, and a great degree of preſſure is requiſite in order to dry it completely; it is then denſe, brittle, and begins to aſſume a ſemi-tranſparency: in this ſtate

ſtate its aſpect preſents the notion of a concrete albuminous ſubſtance. The average quantity of the caſeous ſubſtance is eſtimated at $\frac{1}{1}$. of the entire milk. There are great varieties in this proportion,

50. The caſeous matter, well condenſed, kneaded and deprived of all the ſerum by preſſure, and well ſeparated from the butyraceous ſubſtance, in conſequence of being extracted with care from ſkimmed milk, expoſed to a gentle fire gradually augmented, ſoftens, becomes ropy, and as it were glutinous and elaſtic; if acted upon by a ſtronger fire it entirely melts, ſwells, becomes brown, exhales a thick fume of a very fetid and ſtrongly ammoniacal ſmell, and at laſt takes fire, flaſhes of white and brilliant flame eſcaping from ſeveral points; it leaves a pretty denſe coal. If we diſtil it in the retort, we obtain a red, turbid and fetid water, charged with zoonate and carbonate of ammonia, a very thick oil, almoſt concrete, of a deep brown colour and of an inſupportable ſmell, concrete ammoniacal carbonate ſoiled by a little oil, much carbonated and ſulphurated hidrogen gas, with carbonic acid gas, and a hard coal, adhering to the glaſs, brilliant, difficult to be burned, the aſhes of which preſent in analyſis only a little muriate of ſoda, and the greater part phoſphate of lime. No carbonate of ſoda or metallic oxide is found in it.

51. Expoſed to the air in its dry ſtate, the caſeous matter remains and is preſerved with-

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out alteration; but if it retains a portion of ferum between its parts, it firft turns four at a temperature exceeding 12 degrees; it afterwards putrefies, foftens at its furface; there flows from it a kind of fetid fanies; ammoniacal gas is difengaged from it, and infupportable fetid odour, that fubfifts for a very long time, very tenaceous and which appears to be owing to a compound gas, that efcapes but very flowly and with much difficulty; it paffes at the fame time through feveral fucceffive tinges, orange, red, brown, blue, &c. Every one knows the horrible infection diffufed by old or putrefied cheefe, and the adhefion, the kind of fixity which this odorant fubftance acquires upon different bodies, the wood-work and even the walls which are impregnated with it. The total decompofition of this fubftance is of a very long duration, and it prefents, like the flefh and other animal fuftances already indicated, a fatty and very fufible body, reduced to an ammoniacal ftate by the ammonia, the complete deftruction of which lafts for a great length of time: the contact of water in abundance abridges its duration.

52. Cold water fcarcely diffolves cheefe at all; it holds its moft divided flakes for a longer or fhorter fpace of time in fufpenfion; boiling water, without really diffolving it, foftens it and contracts a pretty ftrong adhefion with it. Scheele has obferved that the cafeous fubftance, precipitated

precipitated by an acid foreign to the milk, is partially ſoluble in boiling water; but this ſolution does not ſucceed unleſs it be effected at the very moment when the ſubſtance has juſt been precipitated: if we leave its flakes for ſome time to unite and condenſe, it is no longer poſſible to accompliſh it. When the caſeous matter has remained for a ſufficient time in cold water, we find it converted into a fat, unctuous, fuſible body, very ſoluble in the cauſtic alkalies and of a fetid ſmell. Water therefore accelerates the ſpontaneous decompoſition to which this animal matter is naturally ſo much diſpoſed. This is the reaſon why dry cheeſes, expoſed in moiſt places, ſoften, increaſe in weight, acquire a ſmell, a taſte, in ſhort a ſtate, different from what they had at firſt; it is in this manner that they are matured according to the common expreſſion, and thoſe qualities are given to them which are ſo much in requeſt amongſt perſons who prefer of this kind of food.

53. The powerful and concentrated acids act rather ſtrongly upon the caſeous matter, and diſſolve it eaſily with the aid of heat; but if diluted with water, or naturally weak, they do not by any means exert the ſame action upon it. The nitric acid turns it yellow, diſengages from it azotic gas, Pruſſic acid and carbonic acids, and changes it partly into fatty matter, partly into oxalic acid. There is alſo formed a ſmall quantity of bitter matter, which adheres in

in a great meafure to the yellow oil and which colours the fingers.

The cauftic alkalies, in highly concentrated leys, alter the cafeous matter at the very moment of their contact; and feparate from it azote and hidrogen, which immediately unite into ammonia, and they convert its refiduoual portion into a kind of oil with which they unite in the faponaceous ftate. Ammonia diffolves the cafeous matter rapidly and abundantly when recently precipitated or coagulated, and this folution is confidered as one of the moft fpeedy and powerful. Quick-lime forms with this matter, when ftill humid, a kind of pafte fufceptible of great folidity and adhefion: this mixture is employed as one of the beft cements for porcelain. There is reafon to believe that a ftill more folid cement might be made with barites and ftrontian.

54. The falts have not the fame folvent action upon the cafeous matter, but almoft all of them oppofe its fpontaneous decompofition; accordingly the muriate of foda is more efpecially employed both as a means of prefervation and as feafoning, in order to make the cheefes keep, and to retard the feptic alteration which tends to deftroy them. An old prejudice, which I have already combatted, has caufed it to be afferted that the fmall quantity of this falt accelerates their fermentation; but it is eafily found by obfervation that it is not with the intention of favour-

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ing it that this faline condiment is employed, but rather with that of limiting it, by covering the furface, by abforbing their humid portion, by concentrating their commencement of their feptic alteration in their centre, or confining it to their exterior part, according to the foft or folid nature of thefe preparations. The fame is the care with the oxides and efpecially the falts of metals, which condenfe, contract, dry, and confequently preferve the cafeous matter, either by the approximation of its molecules, or by abforbing its humidity, or by preferving it from the external moifture.

55. Many vegetable fubftances are fufceptible of uniting with the cafeous matter when frefh, foft and humid; it is rendered mifcible with water by triturating it with mucilages; it adheres to the faccharine fubftance; it becomes charged with feveral colouring matters; it unites by trituration with the fecula; it combines with tannin, and becomes hard and dry in this tanned combination. Its habitudes with the animal fubftances are as yet not well known; no attempt have yet been made to determine its relations with the albuminous and gelatinous liquors, with the fat juices, with fibrine, with the moft complicated animal liquors, though it is eafy to be conceived that inquiries of this kind might procure an acquifition to animal philofophy, by afcertaining the mifcibility, the folubility, the re-action and the reciprocal alteration which thofe different organic

organic compounds may prefent amongft themfelves. It is very evident that this cafeous fubftance is intimately mixed with the butyraceous oil and the gelatin in milk, and that it is to thefe fubftances that owes its folubility or adhefion with water, which forms the vehicle of the different materials of this liquid.

56. All the lights that have been acquired relative to the properties of the cafeous fubftance have induced modern chemifts to think that this fubftance has a remarkable analogy with albumen; and in fact it is amongft the different animal materials that which the cafeous fubftance refembles the moft in its coagulation by the fire and by the acids, its folubility in ammonia, its products in diftillation, or its alteration by the nitric acid. But notwithftanding this analogy, there are however fome remarkable differences between the albumen of the blood and the cafeous fubftance, which indicate, that though the latter proceeds from the blood, it has undergone in feparating from it, and in order to affume the milky form, a modification which has not yet been appreciated. Citizens Deyeux and Parmentier believe that it is to the cafeous fubftance that the milk owes its opaque whitenefs, and not to the oily particles fufpended by its combination with them, that it is confequently inaccurate to compare milk to an emulfion. If they poffefs facts in fupport of this new mode of confidering the union of the cafeous part with the

the water, we ſhould ſee in the opacity of this ſolution a ſufficiently demonſtrative indication of a more advanced oxigination in this ſpecies of albumen of the cheeſe, than in the other known ſpecies of this animal matter. We ſhould even find here a rather ſingular analogy between the caſeous albumen whitening water by its ſolution and the cerebral albumen which dilutes in it, partly diſſolves in it, and equally gives to water the emulſive appearance.

Rouelle the younger has eſtabliſhed a marked analogy between the caſeous matter and the glutinous ſubſtance of the flour of wheat; he ſucceeded by ſalting and kneading the latter with muriate of ſoda and a ſmall proportion of diluted ſtarch, in giving to the farinaceous glutin moſt of the characters, the taſte, the ſmell, the unctuoſity of cheeſe, and he exhibited in his lectures ſpecimens, which by this preparation, had acquired the properties of old cheeſe in ſo characterized a degree that it was no longer poſſible to diſtinguiſh them from it.

SECTION

SECTION VI.

Of the Butyraceous Matter, and of Butter.

57. I DISTINGUISH the butyraceous matter from butter, becaufe the firft, being contained in the milk at the moment when it is formed, is not yet butter, and becaufe this laft exifts only when the milk has remained for fome time at reft after having been drawn from the animal which affords it. It is with this fubftance relatively to thefe two ftates as with the cafeous part and cheefe: the firft, being contained ready formed in the milk, may be feparated from it without intimate alteration; but it becomes cheefe, as we have feen, only by undergoing a more or lefs confiderable modification and change, from even the frefheft cheefe to that which is the moft advanced or the neareft to its putrid decompofition. Butter prefents in its feparation and formation a ftill more confiderable difference from the milky ftate than the cafeous matter does, at leaft as far as concerns its mere precipitation from the milk. It is upon this remarkable point in its hiftory that I fhall firft dwell, as it has not yet been properly treated by the chemifts who have gone before me. In 1790, I publifhed, according to a feries of experiments made

made in the courſe of the lyceum of this year, a new point of theory, relative to the formation of butter. I remarked that the cream was formed more abundantly in the air than in cloſe veſſels and in vacuo; that it was neceſſary it ſhould remain expoſed to it for ſome time, in order to render it capable of affording butter; that butter could not be extracted from recent cream; that in proportion as it remained in the air, it became more ſolid, condenſed, and aſſumed a yellow colour; that it required at leaſt four times longer ſpace of time to ſeparate the butter from cream formed in twenty-four hours, than to extract it from cream eight days old; and that all this proved an action of the air, which contributes to the formation of the butter, to its concretion, and ſeparation.

58. The production of the butter is to be underſtood in the following manner, according to the conſtant facts well known in all dairies and farms. The butyraceous matter, contained in the milk in the ſtate of a liquid, and white oil, ſuſpended in the ſerum, with the aid of the mucoſo-ſaccharine body, and of the caſeous ſubſtance, ſeparates, by means of repoſe, and ſwims at the ſurface, with a ſmall portion of ſerum, and of caſeous flakes, to which it adheres. This compound, which is more oily and more light than the ſerous and caſeous liquor, in proportion as it obtains the contact of the air by remaining above this liquor, abſorbs the atmoſpheric oxigen, becomes ſolid, concrete, coloured;

coloured; in ſhort, real butter. However, butter may be prepared with milk newly drawn, by agitating it for a long time; whence I conclude, that there is in the milk a ſufficiency of oxigen to ſaturate the butyraceous matter by this percuſſion. On the other hand, there are ſome creams, from which butter cannot be extracted by churning them for a great length of time, and which we are obliged to abandon as to that purpoſe. In general the cream is left expoſed to the air for five or ſix days before the butter is churned; and in the great rural eſtabliſhments, this operation is performed only twice every decade: there are many varieties in the properties of milk, relative to the quantity and the quality of the butter which it affords, and ſtill more particularly with reſpect to the facility with which the butter ſeparates from it. A connected ſeries of obſervations, and ſome ſingle experiments, would be requiſite, in order to determine the cauſe of theſe varieties.

59. Chance firſt preſented the ſeparation and concretion of the butter in agitated milk: the ſkins in which the Tartars, and the paſtoral nations tranſport their milk, whilſt they inceſſantly change their abodes, and wander in the deſarts with their beaſts, muſt have exhibited to them this product concreted into ſolid lumps by agitation and percuſſion againſt the ſides of theſe veſſels; and the agreeable taſte of this product muſt have recommended its uſe, and dictated

dictated to them the art of providing themselves with it; accordingly, we find traces of it in the most remote antiquity, which are lost even in the first traditions of the human race. The mode of churning the cream, or the butter, varies according to the countries, and the quantity of it that is fabricated: it is in general by turning or moving with rapidity, an axis provided with fans, or kinds of agitators, in vessels more or less capacious, which are in part filled with cream. They are kinds of churns; the former fixed horizontally, the latter placed vertically, which serve for the operation. During a percussion, or rotation of some hours, the motion of the axis, and of the fans which it bears, after having been gradually impeded, is suddenly stopped by the mass of butter which adheres to it, and attaches itself entirely to it. This mass is afterwards kneaded in water, in order to separate it accurately from the portion of whey and of caseous flakes, which are interposed in it.

60. We see from this description, that butter is obtained from the milk but slowly, and by means of a long and violent agitation, which modifies the butyraceous matter, by causing it to absorb a portion of the oxigen of the milk; that it is much easier to be prepared with cream, and that a much less considerable percussion then effects its concretion; that older the cream is, the more speedily the operation is performed; that the butter does not

therefore

therefore exist ready formed in the milk; and that at the moment when it is saturated with the oxigen it requires, the butyraceous matter is converted into butter and quickly concretes into a mass, which no longer adheres to the serous liquor of the cream, because the attraction between its own particles is more considerable than that which it has for the other principles of the milk. When this production, and separation of the butter have taken place, there remains a yellowish liquor, sometimes of a slight orange colour, which is called butter-milk: it is more fluid than milk that has not been deprived of its cream, of a mild and agreeable taste, altogether similar in its nature to milk that has been entirely deprived of its cream. Citizens Deyeux and Parmentier have made a particular examination of it: they have found that butter-milk is coagulated by runnet with great difficulty, that the acids and alcohol separate caseous matter from it easily and speedily in very fine flakes; and that it has a very great disposition to turn sour.

61. Butter, thus prepared, is generally of a yellow colour: there is some which is white, like a kid of fat; this is considered as inferior to the former. It is believed that this difference of colour depends upon the nature of the aliments; but it is well known to the country people, that it depends upon the diversity of the individuals that afford the milk; that one cow will constantly give white butter, and another

other yellow butter. The contact of the air alfo influences the colouration of the butter; old cream affords yellow, and new cream paler butter. The lumps of butter expofed for fale, are of a deeper yellow colour at their external furfaces, than in their interior parts. Frefh butter has a fweet and unctuous tafte, which is very agreeable, and on account of which it is employed as a feafoner: the difference of the food of the animals has much influence upon this property of the butter. Its foft and very ductile confiftence, though in general it is concrete, varies alfo according to a great number of circumftances. All the phyfical properties of butter are fubject to vary according to the fame circumftances.

62. Very frefh butter melts at a temperature of 29 or 30 deg. Reaumur. When we keep it melted in a tube of glafs, plunged in boiling water, there feparates from it, and fwims at the furface, a white liquid, filled with fmall opaque flakes, which are a mixture of ferum of milk, and of cafeous matter. By this feparation, the butter becomes almoft tranfparent; but it has then loft its fweet and unctuous tafte, and it has become fatty and infipid: whence it refults, that frefh butter owes its fweet, agreeable tafte, to a portion of a ferum, and of cafeous matter. Accordingly, melted butter, with whatever caution it may be prepared, becomes more greafy, of a granulated confiftence, and of a

 tafte

taſte infinitely leſs agreeable than that which it had before. If the butter has been heated only to the temperature neceſſary for melting it, it fixes as it cools, and preſents no ſigns of alteration. When diſtilled in a ſmall retort, it affords ſome drops of water, rendered acrid by the ſebacic acid which it contains: the greater part of the butter riſes and paſſes over entire, with a ſtrong pungent, and very diſagreeable ſmell, as we ſee in culinary operations, where ſo many diſhes are prepared with browned or ſcorched butter; much carbonated hidrogen gas is diſengaged, and there remains only ſome traces of a denſe coal, difficult to be burned, and containing ſcarcely any thing elſe than a little phoſphate of lime. By re-diſtilling the products of the butter, we render the oil lighter and more volatile. If we diſtil it in a very large veſſel, containing much air, we obtain more water, more ſebacic acid, a leſs concreſcible oil, more of gaſeous fluid, and more coal, ſince the air of the apparatus contributes to the deſtruction of the butyraceous matter by furniſhing its hidrogen with a quantity of oxigen ſufficient for burning it. The ſebacic acid is not contained in the butter but is formed here, as in diſtilled fat, at the expenſe of its decompoſition, and of another arrangement of its principles.

63. Butter ſuffers from the contact of hot air, an alteration which renders it acrid and odorous. This rancidity proceeds from the

 formation

formation of febacic acid, which takes place with confiderable celerity. Wafhing with water, and with alcohol, deprives the butter of a great part of thofe difagreeable properties.

Butter unites by fufion with phofphorus and with fulphur, in the fame manner as fat does.

The acids likewife act upon it in the fame manner; the concentrated fulphuric turns it brown, and reduces it to coal; the nitric yields to it a portion of its oxigen; the others have no action upon it.

The alkalies diffolve it very well; foda forms a folid foap with butter, which might be employed with advantage in medicine. Barites, ftrontian, and lime, harden it by combination. Ammonia, alfo, approaches it to the faponaceous ftate, but leaves it liquid. The foaps of butter, when burned and calcined, afford alkaline, or earthy febates, like fat: and thefe febates are alfo produced by the action of the fire.

The metallic oxides unite with butter, by the aid of fire, and form with it metallic foaps, little or not at all foluble, of a plaftic confiftence. In the heat it decompofes the metallic folutions, and takes from them, efpecially from the nitrates, the oxides with which it combines.

64. Amongft vegetable fubftances, butter unites with the extracts; the gums, and fugar, triturated with it, render it mifcible with water; it combines eafily by fufion with the refins, the gum-refins, and the balfams; it dif-

ſolves eaſily in the fixed and volatile oils; it abſorbs camphor, and retains it ſtrongly; it attracts ſeveral colouring matters, with which it adheres forcibly. The laſt-mentioned property has long been employed for giving butter a more or leſs intenſe gold colour; for this purpoſe, carrots, the curcuma, the marigold, the ſeeds of aſparagus, the berries of ſolanium kalicacabum are uſed. The colours of butter may be greatly multiplied, and ſingularly varied. The root of the alkanet gives it a brilliant roſe colour, the violet a dull, but pretty intenſe blue; the leaves of ſpinnage, a brilliant green colour. The proceſſes conſiſt in mixing the colouring matters, pounded or chopped, with the cream before it is churned; the colour thus paſſes into the butter at the moment when it becomes concrete, but not before this period. Butter, coloured in this manner, keeps for a long time; it is even difficult to diſcolour it. We may alſo cauſe theſe different colours to paſs into the butter by means of fuſion; but butter, coloured in this manner, cannot ſerve for a ſeaſoning. The highly odorous matters unite with butter with facility, and we may perfume it by their mixture at the moment when it is churned, with cinnamon, cloves, nutmeg, mace, orange or lemon peel, vanilla, &c.; but very little muſt be uſed, in order to communicate to it a perfume, without acrimony.

65. It may be concluded from all that has been

been ſtated, that butter is a kind of concrete and oxigenated oily humour, reſembling fat, and not a vegetable oil, united with an acid, as was formerly believed; that this ſubſtance, without being entirely conſtituted butter in the milk, has, however, a great diſpoſition to become ſuch, and to ſeparate from this liquor in proportion as it abſorbs oxigen from the atmoſphere, when milk, and ſtill better when cream, is agitated in contact with the air; that butter, which owes its qualities as freſh butter to the mixture of a ſmall portion of ſerum, and of the lighteſt caſeous matter, and loſes them by the ſlighteſt fuſion, comports itſelf afterwards like a kind of fat, in all combinations, as well as in all the analytical proceſſes to which it is ſubjected; and that laſtly, there is reaſon to believe, according to theſe chemical phenomena, as well as from the anatomical obſervations of the celebrated Haller, that the fat which every where ſurrounds the mammary glands, contributes, by means of the ducts deſcribed by this great anatomiſt, to the formation of milk, probably by furniſhing it with the baſis of the butyraceous matter, whilſt the lymph gives it the mucoſo-ſaccharine principle; and the blood, the albumino-caſeous ſubſtance, as well as the ſalts which are diſſolved in it.

Section VII.

Of the different Kinds of Milk, compared with that of the Cow.

66. In the general examination of milk, and of its different parts, which has hitherto formed the object of this article, I have taken the milk of the cow as an example, as a mean term of all thefe kinds of animal liquors, as that which is moft frequently employed, and for the greateft number of ufes, becaufe it is procured more abundantly, and more eafily than any other. But it is equally ufeful, and even neceffary for many circumftances of life, to know the characters and the nature of the other kinds of milk which are employed, either often, or only fometimes, as aliments, or as medicines, or as objects of rural manufactures, and the fubjects of products advantageous to whole countries. We muft therefore compare together the milkof woman, and thofe of the afs, the goat, the ewe, and the mare; all of which, when referred to what I have faid concerning the milk of the cow, will require nothing more than the fimple expofition of their differences. Moft of

of the authors quoted in the beginning of this article, have ſpoken more or leſs concerning thoſe differences; but none have made them the object of more attention and ſtudy than citizens Deyeux and Parmentier. I ſhall therefore more eſpecially follow them in giving the ſpecific characters of each kind of milk, attending, like them more to the quality than the quantity of their principles; becauſe the latter, varying according to a multitude of circumſtances, preſent nothing conſtant to the obſerver.

A. *Woman's Milk.*

67. The milk of the woman is generally known to be leſs thick, leſs opaque, and more ſaccharine than that of the cow. Its coloſtrum frequently reſembles thin ſoap water; repoſe, cauſes fat and unctuous flakes to ſwim upon it, from which no butter can be extracted by agitation. The liquor, after this ſeparation, is ſcarcely opaque, becomes viſcous, ſour, putrefies, and appears to contain little caſeous matter: ſuch is the coloſtrum of the firſt day. That of the ſecond, which is whiter, affords a kind of flakey cream, which does not yield butter any more than the preceding; that of the third and of the fourth day aſſumes the character of real milk, ſtill without the poſſibility of extracting butter from its cream: the acids coagulate it well, and its ſerum is eaſily clarified.

The

The well-formed milk, examined at different periods till the eleventh month after lying-in, prefents varieties, even at different times of the day: it, however, gradually diminifhes in quality, in general, proportionably to the length of time that has elapfed fince delivery. Its cream, which is very abundant, fometimes does not admit butter to be feparated from it; it is then very liquid, unctuous, and feems to contain an oil that is not concrefcible.

68. When the cream of woman's milk is thick, it affords by agitation firm butter, a little yellowifh, of an ordinary tafte, and in fmall quantity. All the proceffes which coagulate the milk of the cow, produce the fame effect upon that of woman; the cheefe is in general foftifh, unctuous, and does not acquire the fame concrete ftate. The clarified ferum is fcarcely coloured, its tafte is more faccharine than that of cow's milk; it contains only a little more of the mucofo-faccharine principle; Haller, however, has indicated its proportion to that of the cow, according to Navier, Hoffman, and Yonna, as 67 to 54. This ferum is lefs compounded than that of the cow, it contains lefs falts, and it is to this circumftance that citizens Deyeux and Parmentier attribute its more faccharine tafte. There is no milk that fhows itfelf more variable in its analyfis than that of woman. Upon the flighteft change in the ftate of the health, it lofes its confiftence;

after

after ſpaſms it contains no more caſeous matter; it is then repugnant to the infant, who does not take the breaſt again till when the milk has returned to its natural ſtate. Thin and delicate women frequently yield ſtronger and more abundant milk than fat women. It is known with what facility the medicinal, and particularly the purgative properties, paſs from nurſes to their ſucklings; this is much more remarkable in women, than in the female animals.

69. Citizens Deyeux and Parmentier have examined even the differences which ariſe from the different methods of ſuckling the infants. According to their obſervations, great inconveniences ariſe from making them ſuck often, and letting them take only a ſmall quantity of milk at a time: it is then always too ſerous. Women, who without being aware of this, and in order to mitigate the cries of their infants, acquire the bad habit of giving them ſuck very often, and thus afford them always a too liquid or ſerous milk, in ſmall quantities at a time, are much more ſubject than others to repletions of the breaſts, and all the affections which depend upon the alteration and detention of this liquid in the mammary ducts. It appears that a phenomenon here takes place analogous to that which is obſerved in milking cows at divided periods; it has been ſeen that the firſt milk is the moſt ſerous, the leaſt thick, and the leaſt fat; and that its properties regularly

improve

improve to the laſt ſtage of milking; in this manner it is that milk-women procure creamy milk. It will therefore be attended with great advantage, both to the infant and the mother, to let the infant ſuck only at ſtated periods ſufficiently remote from each other, in order that the homogenous milk may be entirely drawn out by the ſuckling, whoſe deſire for it is then greater, and who exhauſts the breaſt more completely.

B. *Milk of the Aſs.*

70. The ſhe-aſs, when well fed and attended, affords milk always more fluid than that of the cow, the conſiſtence of which more reſembles that of the woman. It is in general not very palatable; it conſtantly affords a white ſoft butter, very liable to rancidity. Runnet, the acids, and all the well known means coagulate the aſſes' milk; its coagulum is commonly in a magma, one part of which floats upon the ſurface of the liquor, whilſt another is precipitated. The ſerum is very eaſily clarified. It has not more, or very little more colour than that of woman's milk; it is a little leſs ſaccharine than the latter, but ſenſibly more ſo than the whey of cow's milk. Haller, however, indicates for the quantity of the mucoſo-ſaccharine ſubſtance contained

contained in affes' milk, a greater proportion than for that of the woman. This proportion, according to him, is as 82 to 67; fo that this liquor appears to be that which, of all, contains the moft fugar of milk. Citizens Deyeux and Parmentier affure us, that by examining comparatively the milk of three affes, they found many varieties in the ferum which they obtained from it. It appeared to them to contain the fame falts as that of the cow, but in fmaller quantity.

C. *Goat's Milk.*

71. The milk of the goat is the thickeft of all, according to the fame chemifts. It has a fmell which is difagreeable to fome perfons, but which may be diminifhed by attention and cleanlinefs in the feeding of the animal: that of white goats is lefs odorous than that of black ones. It affords much cream, and this yields much butter. The butter of goat's milk is white, it acquires much folidity, and keeps for a long time without becoming rancid. The fame milk alfo contains much cafeous matter, which is eafily feparated from it by all the well known means. It is obtained in the form of a very denfe, very thick curd. The ferum of this milk may afterwards be well clarified; it is generally yellowifh, with a greenifh caft. According

cording to Haller, the proportion of the ſugar of milk contained in it, with relation to that of cow's milk, is as 42 to 54; and according to citizens Deyeux and Parmentier, it does not contain leſs of it than the latter: but what has appeared to them very remarkable is, as they aſſert, that they found in it only muriate of lime, after having extracted from it the mucoſo-ſaccharine matter. We ſhould be led to believe that the phoſphate of lime ought alſo to be abundant in it, from the thickneſs, the hardneſs, and the length of the hair of this animal, upon the nature of which, this ſalt has much influence, as I have already indicated in the article concerning the analyſis of the hair.

D. *Ewe's Milk.*

72. Though at firſt ſight this is little different in its aſpect from the milk of the cow, it preſents, however, in the analyſis, eſpecially in that made by citizens Deyeux and Parmentier, well-marked characters which diſtinguiſh it. It affords a cream which is abundant, but has little thickneſs, from which is ſeparated a ſoft very fuſible butter, of the conſiſtence of a fixed oil, of a very pale-yellow colour, which eaſily becomes rancid. Its caſeous matter is fat and viſcid; its ſerum, which in general is difficult to be clarified, eaſily yields ſugar of milk almoſt pure

pure from the firſt cryſtallization, according to the above-mentioned chemiſts. It is, however, of all kinds of milk, that which, according to the authors collected and compared by Haller, affords the leaſt of this mucoſo-ſaccharine ſubſtance; its proportion to that of the cow is as 37 to 54. The ſerum, after the extraction of this ſubſtance, contains muriate of lime in very ſmall quantity, according to citizens Deyeux and Parmentier.

The moſt remarkable difference, or the moſt prominent character of the milk of the ewe, conſiſts in the properties or conſiſtence of its caſeous part: its viſcid and ſoft ſtate is the cauſe of the fatty conſiſtence which the cheeſes prepared with it conſtantly preſent. On this account, it is the practice in ſome countries to mix ewe's milk with the milk of the cow and the goat, in order to give to the cheeſes which are fabricated there, a more unctuous and marrow-like quality, and a ſofter paſte, which does not dry without difficulty

E. *Mare's Milk.*

73. This is the moſt fluid milk of all that have been mentioned. It has hardly any ſmell or taſte. The ſmall quantity of cream which it affords is very liquid, yellowiſh, and furniſhes only, with difficulty, a ſmall quantity of bad-conditioned butter; it ſeems that the caſeous matter,

matter, which is difficult to be feparated from this milk by the vegetable acids, remains adhering to the butter, for there remains a portion of it diffolved by thefe acids, as well as by the ferum. However, this is eafily clarified, and fugar of milk obtained from it by evaporation.

According to the extracts compared by Haller, mare's milk is the fecond in the order of the milks, with refpect to the quantity of fugar which it yields; it follows immediately after affes' milk, and ftands in the interval between this and the milk of women. The proportion of this mucofo-faccharine principle, relatively to that which cow's milk prefents, is, according to this celebrated phyfiologift, as 70 to 54. It is known, that mare's milk, kept for fome time, acquires an intoxicating quality, and it is in this milk that this property of vinous fermentation has firft been obferved.

F. Materials of the different Milks compared with each other.

74. By comparing, according to the details given relative to each milk in particular, the conftant nature, more ufeful to be known than the variable proportion of the products extracted from them, the following refults have been afcertained by citizens Deyeux and Parmentier by their inveftigations.

All

All the milks become covered with cream at their ſurface, but it varies in the different kinds of milk.

a. In the milk of the *cow*, it is abundant, thick and yellow.

b. In *human* milk, more liquid, white, in ſmall quantity.

c. In *goat's* milk, more abundant than in the milk of the cow, thicker, whiter, and eſpecially leſs aceſcent.

d. In *ewe's* milk, almoſt equally abundant and yellow as in that of the cow, but always diſtinguiſhable by a particular taſte.

e. In *aſſes'* milk, not thick, little abundant, frequently ſimilar to that of human milk.

f. In *mare's* milk, very fluid, ſimilar in colour and conſiſtence to good cow's milk, from which the cream has not yet ſeparated.

75. The butter, is always oily, ſweet, very fuſible, and has the following comparative properties.

a. Extracted from the cream of the *cow*, it is ſometimes very yellow, ſometimes pale, fequently white, and always conſiderably conſiſtent.

b. Difficult to be extracted from the cream of *human* milk, in ſmall quantity, inſipid, of a pale yellow colour, frequently inſeparable from the cream, which it renders unctuous; whence it has been erroneouſly inferred that this milk affords no butter.

c. The

c. The butter of *aſſes'* milk is always very white, ſoft, very ſubject to ſpeedy rancefcence.

d. The butter of the *goat* ſeparates eaſily from the cream, is very abundant, always white, firm, ſoft, and ranceſcible.

e. The butter of the *ewe*, is rather yellow, always ſoft, conſiderably ſubject to rancidity.

f. The butter of *mare's* milk is difficult to be obtained in ſmall quantity, it does not aſſume conſiſtence unleſs by waſhing in cold water, and is much diſpoſed to rancidity.

76. The caſeous matter is alſo a conſtant product, one of the conſtituent materials of milk; it varies in the ſpecies in the following manner.

a. That of the *cow* is voluminous, tremulous, ſeemingly gelatinous, very abundant, retaining much ſerum which is made to flow out by a ſlight preſſure.

b. That of *woman's* milk is little abundant, without coheſion between its particles, always unctuous and ſtringy, retaining but little ſerum between its particles.

c. That of the *aſs*, nearly ſimilar to the preceding, without unctuoſity.

d. That of the *goat*, in large quantity, in a thick coagulum, more denſe than the curd of cow's milk, retaining leſs ſerum.

e. That of the *ewe*, always fat, viſcid, difficult to be condenſed into curd, and giving a ſoft paſte to the cheeſes.

That

f. That of *mare's* milk little abundant and very ſimilar to that of human milk.

77. The ſerum conſtitutes in general the moſt abundant part of the milks; it varies in the different ſpecies as follows:

a. The clarified ſerum of *cow's* milk is ſometimes of a pale yellow, ſometimes of a greeniſh colour, containing ſugar of milk and ſalts.

b. That of *woman's* milk, is little coloured, of a very ſaccharine taſte, being the third, according to Haller, with reſpect to the proportion of the mucoſo-ſaccharine ſubſtance.

c. The ſerum of *aſſe's* milk is without colour, containing leſs ſalt and more ſugar of milk than that of the cow.

d. The ſerum of *goat's* milk is ſcarcely yellowiſh, a little ſaccharine, holding the laſt place but one with reſpect to the quantity of ſaccharine matter, with few ſalts, almoſt ſolely the muriate of lime.

e. The ſerum of *ewe's* milk is almoſt always colourleſs, of a faint, and as it were greaſy taſte, the leaſt charged with ſugar of milk, containing muriate and phoſphate of lime in ſmall quantity.

f. The ſerum of *mare's* milk is little coloured, the ſecond, according to Haller, with reſpect to the quantity of ſaccharine matter contained in it; according to Deyeux and Parmentier, charged with more ſaline matters than moſt of the other milks.

Section VIII.

Of the Uses of Milk.

78. THE uses of milk are extremely numerous and always of great importance. They may be considered under the fourfold relation of natural uses, economical uses, medicinal uses and uses in the arts. Under the three first of these relations this alimentary and medicinal liquid constitutes the opulence of several whole nations wise in their simplicity, and happy enough in what we call their barbarism, to place their wealth in the abundance of their cattle, which furnish them with what they require for satisfying all their wants. The pastoral or erratic nations, who live almost entirely upon milk and its products, and the times in which a great number of those which are now civilized derived from it their simple nourishment, recal to our minds those happy days which the poets have depicted to us as the golden age, and it appears to the philosopher who compares those happy ages and people with those of the present day, that the mildness of this aliment of the first inhabitants of the earth, must have had an influence upon the gentleness and amenity of the manners of antiquity.

79. By ſwelling the mammæ of the mothers with milk immediately after parturition, nature has given to animals the two-fold advantage of a nouriſhment neceſſary to their young, and an evacuation uſeful to the mothers. The latter, after the abundance of the fluids which have long diſtended their uterine ſyſtems, find in the evacuation of the milk a diſcharge for thoſe redundant fluids, whilſt their young derive from it a ſupport appropriated to their weakneſs, at firſt laxative, but afterwards becoming more and more nutritious, eaſy to be aſſimilated into their own ſubſtance, and containing, by an admirable inſtitution of Providence, the ſolidifiable matter of their bones in a proportion correſponding with the rapid augmentation which theſe organs muſt experience during the firſt period of life. In this two-fold point of view, it is evident, that it is equally neceſſary to the mothers, after delivery, to evacuate this ſuper-abundance of fluids, and to the young to nouriſh themſelves with it: and that while the former cannot without danger renounce the ſuckling of their young, theſe likewiſe cannot be deprived of this aliment without inconvenience. Accordingly, ſevere, painful and frequently fatal diſeaſes are the juſt puniſhment of mothers who renounce this duty, whilſt a permanent weakneſs and languor throughout the whole of their lives, impend over the young animals that are deprived of this food.

80. Man muſt ſoon, and almoſt in the firſt ages of the world, have been led by obſervation to employ as food the milk of the animals which he has been able to tame and render ſubſervient to his wants. Accordingly, the different alimentary preparations of milk are traced back to the moſt remote ages of antiquity. The abundance of milk laſts only for a ſeaſon, or at leaſt it is ſoon too much diminiſhed to be ſufficient for the ſupply of the wants of man; it was therefore neceſſary that means ſhould be diſcovered for preparing it in ſuch a manner that the ſuperfluity of one period of the year might be kept to ſupply the deficiency of the others. Hence the different kinds of cheeſes. The natural alterations which milk undergoes, being early obſerved, have alſo given riſe to the great multitude of various aliments that are prepared with this liquid, eſpecially cream, butter, curd, butter milk, ſour whey, &c. The Tartars have long poſſeſſed the art of preparing intoxicating liquors with milk. Its employment as a ſeaſoner, its mixture and combination with fruits, honey, ſugar, the different infuſions and decoctions, the vegetable perfumes which add more or leſs agreeable taſtes and ſmells to the mildneſs and unctuoſity of milk, were not contrived till long after the diſcovery of the products obtained from this liquid. Art has ſo much multiplied this preparation, that it would be uſeleſs to attempt their enumeration;

meration; befides which they vary in different countries. Modern chemiftry has ded to the ancient economical ufes of milk, that of converting it into vinegar, which in ertain provinces may be an advantageous bftitute for the acid furnifhed by wine, der, beer and the four fruits.

1. There are few medicinal fubftances that been applied to fuch a multitude of ufes phyficians as milk. As a mild, relaxing, nt, cooling fubftance, it is adapted reat number of maladies. There are en upon which it feems to exert a ction, as the attacks of the gout, the , obftinate herpetic erruptions, in- avation of the lungs, ulcerated af- he urinary paffages, &c. To this ommon action of all kinds of milk mal economy, experience has nay add the particular action of milk: that the milk of the afs d the moft eafily digefted; that h heavier and adapted for s ftomachs, and for thofe dy is to be nourifhed and human milk, the fweeteft n, which the cafeous part s on the contrary well chs and difficulty of t is with the intention indications that the he other of the four kind

ds of milk, the human milk, goats' milk, s' milk and cows' milk. They have alfo thought fit to divide the milk and to dilute it with water, to prepare from it the whey or ferum and to adminifter it either fweet and clairified or foured, to combine the different kinds milk with different remedies, to foften or m derate their effects by this addition, or to fa the intromiffion of this liquid into the hum by giving it a little more activity, by c ting its infipidity, its weight upo ftomach, its occafional aftringent effe the contrary its relaxing operation. neceffary that the phyfician fhould be with an accurate knowledge of ch order to be able to prefcribe thefe m thefe combinations of milk wit medicinal fubftances without de properties of the latter: thus know that lime water precipit phofphate from it by paffing itfe that many metallic falts are de and that matters fufceptib coagulate it. Laftly, the milk in medicine has been impregnate it with fome by treating in different furnifh it, or the nurfe infant.

82. The multiplied of animals affords fified forms, leave

... of these valuab
longing to the nou
However, though it be no
arts, it is however not w
point of view. Milk that h
turbid is frequently employe
factories where fine cloths are
to give them that beautiful white
improperly called milk-white. It
lieved in these manufactories that no
stance can be substituted for this lact
though able chemists have maintained
the sulphuric acid diluted with water
duces the same effect. Barrels filled with so
whey are sent from the rich mountains of
Switzerland into France, for the purpose of being employed in this process of bleaching. I have elsewhere observed, that the caseous matter, kneaded fresh with lime, forms a tenacious paste, susceptible of hardening, which is employed for cementing broken porcelain together. Rancid butter is rendered subservient to a number of uses by the industry of the chemical arts: it is manufactured into soap, and other compounds.

END OF THE NINTH VOLUME.

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